THE ILFORD MANUAL

OF

PHOTOGRAPHY

BY

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ONE HUNDRED AND SEVENTIETH THOUSAND.

ILFORD, LIMITED,

ILFORD, LONDON, E.

PRINTED BY
HAZELL, WATSON AND VINEY, LD.
LONDON AND AYLESBURY.

PREFACE.

THIS Handbook has been compiled at the request of the Ilford Company, in the hope that it may be of service to the large number of Photographers who apply the art to pictorial, technical, or scientific purposes, and are content to leave to others the preparation of the sensitive materials that they use. It makes no pretence of being a complete treatise on the principles of the art, and it is not written for those for whom the experimental side of Photography has the most attraction. Its aim will be reached if it serves as a trustworthy guide in the actual practice of the art. At the same time, an endeavour has been made to state, in a simple way, sufficient of the principles to enable the reader to work intelligently, and to overcome most of the difficulties that he is likely to meet with. No claim is made for originality in respect of any of the facts, and it has therefore not seemed necessary to state the sources from which even the newer items of information have been collected.

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CHAPTER I.

APPARATUS.

THE apparatus indispensable for ordinary photography in the field is a camera, a camera-stand or tripod, a plate-holder or dark slide, and a lens; but several accessories are required before an outfit can be regarded as complete.

A *camera* consists essentially of a support for the lens, and a support for the plate, with some opaque material connecting them in order to protect the plate from the action of extraneous light. Cameras of many seemingly different forms can be purchased, but they differ only in constructive details, and are practically all modifications of two original forms which are shown in figs. 1 and 2. A good camera should fold into as small a space as possible, with a view to portability, and should be as light as is consistent with rigidity when set up. Steadiness when in use is the first consideration, and should never be sacrificed to lightness; many of the lighter forms are satisfactory in the smaller sizes if used with care, but are very shaky in the larger sizes. Simplicity in construction is very desirable, and all unnecessary movements, with the complication of screws, hinges, and struts that they involve, should be carefully avoided.

The front of the camera should be as rigid as possible when set up, and the only motion necessary is a rising and falling motion, enabling the lens to be moved up and down in a vertical plane. A swinging motion to the front is generally unnecessary, but may be useful for special work.

The back of the camera must be fitted with a "swing-back," so that the plate can be fixed at an angle with the base-board, and a second swing motion in a direction at right angles to the first is sometimes very useful, though it is not often required except for instantaneous work. The vertical swing is frequently done (fig. 2) from the bottom of the back by means of a hinge that connects it with the base-board, but it is better that the swinging should take place from the centre, the movable

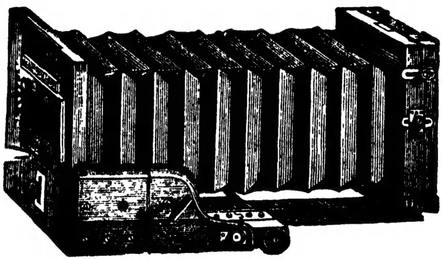

FIG. 1.

portion being hinged to another part of the back which always remains at right angles to the base-board (fig. 1).

The back carries a sheet of finely ground glass, on which the image is projected by the lens, and on which it is focussed; it is absolutely indispensable that the inner surface of this "focussing screen" should coincide exactly in position with the surface of the sensitive plate when the dark slide is placed in the camera, for if this is not the case, the image that seemed sharply defined to the eye will not be sharply defined on the plate. The back should be capable of reversal, so that the longer edge of the plate can be used either in a vertical or a horizontal position according to the nature of the subject. When the reversing back is used it is important to see that

it is properly fitted into the frame, and clamped so that no light can penetrate the line of junction.

The focussing of the image is effected by moving either the back or the front of the camera; the motion being given by means of a rack and pinion, or a screw. In order to permit of the use of long-focus lenses, it is desirable that the camera should be capable of extending to a length of about 12 inches in the case of a $\frac{1}{4}$-plate, 16 to 18 inches for a $\frac{1}{2}$-plate, and 20 to 24 inches for a whole-plate. The bellows is sometimes rectangular, sometimes tapering, and if the latter form is selected, it is important to see that the bellows does not cut off part of the image from the plate when short-focus lenses are used and the back of the camera has to be moved close up to the front.

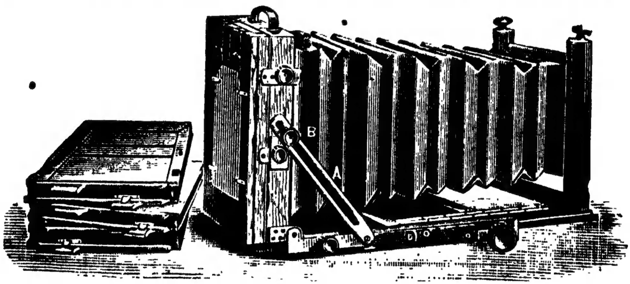

FIG. 2.

Cameras should be kept in a dry place and should be periodically subjected to a very thorough examination, more especially with a view to ascertain whether they remain light-tight, or whether minute holes have made their appearance. Special attention should be paid to the corners and angles of the bellows, the junction of the bellows with the front and the back, and the points where any screws are inserted into the front of the camera.

The dark slides should be of what is known as the book form, and the shutters should have a double hinge so that they can be folded back after being drawn. In some cases the shutter has no hinge, but is made to pull out altogether, access of light through the groove being prevented by a spring cut-off. It is desirable to be certain that this cut-off really does its work,

and, when putting back the shutter, take care to insert it in a horizontal position so that the whole of the end of the shutter enters the slide at once, and not merely one corner of it.

In the case of hinged shutters special attention must be given to the hinge. It must be examined periodically by holding it between the eye and a strong light, in order to ascertain whether it remains quite light-tight. Further, the material of which the hinge is made is important; it has been found that certain substances, especially Russian leather, give off vapours that affect the plates and produce black or transparent bands in the finished negative, the position of these bands corresponding with the position of the hinge of the dark slide. If this should happen, it may possibly be remedied by opening the slide and leaving the inside exposed to air and light for some time; if this plan fails, the old hinge must be removed and a new hinge inserted, the material known as jean giving the best results.

Each slide holds two plates back to back; they are separated by a thin sheet of metal, vulcanite, or card, which prevents the light that passes through one plate from affecting the plate behind. This separating sheet should be attached to the slide at one end by a hinge of metal or jean.

Each slide should be distinctly numbered, and should be fitted with catches to prevent the unintentional withdrawal of the shutters. It should be held in its place in the camera by means of short grooves and a catch; long grooves are very liable to jam. At least three slides, carrying six plates, will be needed for outdoor work.

The *tripod* or camera stand, for outdoor work, should have folding or, much better, sliding legs, the number of sliders being one, two, or three, according to the degree of portability required. Two things must be regarded as essential: (1) it must be quite rigid when set up; and (2) it must be of such a length that it raises the camera to the level of the photographer's eye when he is standing upright. A tripod that necessitates stooping on the part of the user should not be tolerated. Many different forms of tripod are in the market; many of them are bad, but several are good, and each of these has its own advantages. Want of rigidity arises from several causes, such as the use of poor wood; sacrifice of strength to

lightness; bad design, especially in the lower part of the stand. Another common cause of instability is too great freedom of lateral motion at the junction of the legs with the tripod head.

At the top of the tripod is a circular or triangular head, to which the camera is attached by means of a screw. Very frequently this head is too narrow, and consequently the camera is very liable to shake. It is an advantage to have the tripod head covered with felt or some similar material, especially if the head is a metal triangle. The screw for attaching the camera should be fastened to the tripod head in such a way that it cannot be lost; this is best done by having the screw recessed into the hole in the centre of the head. In some cases the base of the camera is recessed, and is fitted with a turn-table to which the tripod legs are attached; this plan avoids the annoyance that arises from loss of the tripod screw, or from leaving the tripod head at home.

A *focussing cloth* will be required for covering the head of the operator and the back of the camera, in order to keep off the light and thus enable the operator to see the image on the focussing screen. It must be opaque, and sufficiently large to cover the whole of the camera as well as the photographer's head; velvet or velveteen is often used, but dark blue twill is lighter and less expensive. If one thickness of twill is not sufficiently opaque it may be lined, or two thicknesses may be used. Some distance from one end of the cloth, and equidistant from the sides, is cut a circular hole, round the edge of which is stitched some strong elastic, the diameter of the hole being such that it will slip over the lens in the front of the camera, whilst the elastic fits moderately tightly round the tube of the lens. By means of one or two hooks and eyes the front corners of the cloth can be fastened together under the camera, and there is then no danger of the cloth blowing away. Moreover, since the cloth covers the whole of the camera from front to back, it acts as an additional safeguard against the entry of light; if hooks and eyes are sewn on the back corners, the cloth can be fastened over the dark slide after the shutter has been drawn, and acts as a protection during a long wait for a favourable moment in which to make the exposure.

Lenses will be discussed in the following chapter.

A *shutter* will be required if rapid exposures are to be given, and "a time and instantaneous" shutter may with advantage be used regularly in place of a cap. For general work, the author recommends the Thornton-Pickard shutter (fig. 3), which is of the "roller blind" form. A rectangular opening in a flexible blind coiled on a spring roller passes rapidly across the lens, which is thus open for a longer or shorter time according to the rate of motion of the blind. The rate of motion is controlled by the number of turns given to the spring of the roller, and the shutter is released pneumatically by pressing an indiarubber ball at the end of a long tube. When the shutter is adjusted for "time exposure," it is opened by pressing the indiarubber ball, and closed by releasing the pressure after any desired length of time. The pneumatic arrangement enables the photographer to stand at some distance from the camera, and to keep his eyes on his subject, not only during the exposure, but also when opening and closing the lens. This shutter can be fixed on the hood of the lens, and by means of indiarubber adapters the same shutter can be made to fit several lenses, if their hoods do not differ too much in size. It is, however, more satisfactory in every way to have the shutter fixed on the camera front, so that it works behind the lens. The lens flange is attached to the front panel of the shutter, and if this flange fits the largest lens that is being used, it is easy by means of adapters attached to the other lenses to make them all work in the same flange. The front panel of the shutter is generally movable, and, therefore, if adapters cannot be used, it is possible, though much less convenient, to have a panel for each lens flange. It is *very important* to take care that the opening at the back of the shutter is sufficiently wide to prevent its cutting off any part of the image. With very short focus lenses it is sometimes impossible

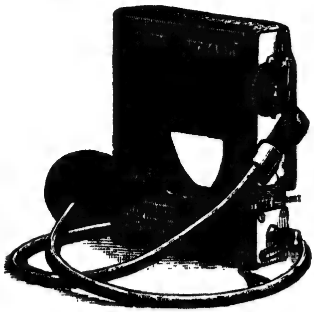

FIG. 3.

to use a shutter working behind, and in that case it is well to have a spare panel to the camera front, with the flange of the short focus lens attached to it, and use the lens cap, since with such lenses very short exposures are rarely required.

Place's shutter (fig. 4) is very simple and convenient, and with care and practice will give exposures as short as one-fifteenth of a second. The moving part consists of a flexible blind passing over a roller, and actuated by pulling a cord. At each end of the blind is a rectangular piece of ebonite, which constitutes the shutter proper, and has the advantage of being perfectly opaque. There is a cord at each side of the shutter, and when one is pulled, one end of the blind rises and gradually uncovers the lens, which remains completely open for a short time, and then the other end of the blind descends and gradually closes the lens. If now the other cord is pulled, the same thing occurs, so that making one exposure sets the shutter for the next. Since the shutter opens first at the bottom and closes last at the bottom, it follows that the longest exposure is given to the foreground and the shortest to the sky, and good clouds can frequently be secured in this way. The length of the exposure depends of course upon how quickly the cord is pulled; and obviously, when the lens is completely uncovered, it may be left in that condition for any length of time, a second pull of the cord afterwards closing it. This shutter may entirely replace the lens cap, and is much more convenient.

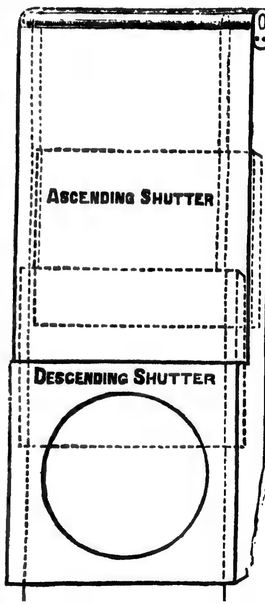

FIG. 4.

A simple drop shutter may be used for moderately quick exposures. A piece of wood, metal, or ebonite, with a longitudinal opening, slides

freely in a frame to which is attached a ring for the purpose of fitting it to the lens. The best form to give to the opening is shown in fig. 5; the time of exposure is longer the longer the opening, other conditions remaining the same. The falling-piece is notched at the edges, and is supported by a catch which is released pneumatically or by a touch with the finger. The speed of the shutter may be accelerated by india-rubber bands passing round pegs fixed in the falling-piece and the frame.

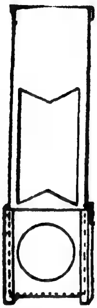

FIG. 5.

Unicum Shutter.—For compactness a shutter working between the components of the lens, or approximately across the middle of the lens barrel, has considerable advantages. The most generally used shutter of this type is the *Unicum* shutter of Bausch & Lomb, which is fitted to many commercial hand cameras, and can be obtained fitted to most of the rapid lenses. It is made entirely of metal, and can be adjusted to give time exposures, or any exposure from a hundredth of a second to one second. The release may be either pneumatic or by means of a trigger. The disadvantage is that, as it has to fit the lens barrel, one shutter can rarely be made to answer for more than one lens, unless they should be of the "Satz" or "convertible" type.

Focal Plane Shutter.—Sometimes a blind shutter is arranged to work just in front of the plate instead of before or just behind the lens, and it is then known as a focal plane shutter. The width of the opening is adjustable, so that it can be reduced to a comparatively narrow slit. With the shutter working at any particular speed, it is clear that the wider the opening in the blind is, the longer will each part of the plate be exposed, and *vice versa*. If the opening is made narrow and the shutter moves quickly, the exposure of any particular part of the plate will be very short, and consequently this form of shutter is preferred by some workers when very rapidly moving objects have to be photographed. Since, however, the plate is not all exposed at once, but different sections are exposed successively as the shutter moves down the plate, there is in certain conditions a peculiar distortion of the image.

A *case* or *cases* will be required to contain the camera, dark slides, etc. It may be made of leather, lined with green baize, and is then strong but very heavy. Ordinary stout waterproof canvas answers very well, and is much lighter. The exact shape of the case will vary according to individual fancy: it should have separate compartments for dark slides lenses, etc. If a large camera is used the apparatus is best divided between two cases, one of which is carried in the hand whilst the other is carried knapsack fashion on the back. Cases carried on the back or across the shoulders should be fitted with broad web straps, instead of the uncomfortable narrow leather straps.

CHAPTER II.

LENSES.

THE lenses used in photography are made of glass, and are "spherical lenses"—*i.e.*, the surfaces that enclose them are parts of the surfaces of two spheres, the centres of which are not usually coincident.

It is not intended in this chapter to explain the principles of optics; certain facts relating to the behaviour of lenses will be stated as concisely as possible, and further information will be found in J. Traill Taylor's "The Optics of Photography," and "The Lens" by Bolas & Brown.

Light travels in straight lines so long as it continues to travel in a medium of uniform density, such as glass or air, but when it passes from one medium into another of different density, as from air to glass, or glass to air, a ray of light is *refracted*, or bent out of its course. The action of a lens on a beam consisting of parallel rays of light is shown in fig. 6; the rays are refracted and brought to a point (f) on the other side of the lens. This point is called the principal focus of the lens, and its distance from the

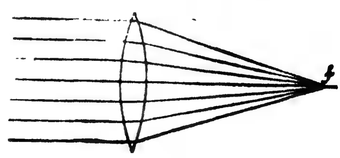

FIG. 6.

lens is called the principal *focal distance*, or commonly, the *focal length*, of that lens. All lenses that are thicker in the middle than at the edges behave in a similar manner, and are known as *converging lenses*. Lenses that are thicker at the edge than in the middle are called *diverging lenses*, and behave as shown in fig. 7. The lenses used in photography are always converging lenses, though diverging lenses are used to form part of some of the compound lenses.

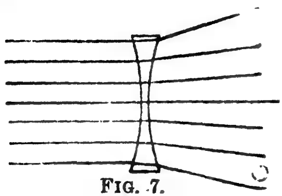

FIG. 7.

When the rays of light are not parallel, but are diverging from a point as at A, fig. 8, they are brought to a point on the other side; but the distance of this point is greater than the principal focal distance of the lens. Further, just as rays proceeding from A are brought to a focus at A′, so rays proceeding from B would be brought to a point at B′. Any alteration in the distance of point A makes an alteration in the distance of point A′; the nearer A is to the lens the farther is A′ away, and *vice versâ*. Pairs of points related to one another

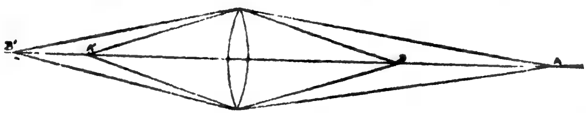

FIG. 8.—Conjugate Foci.

in this way are termed *conjugate foci*. The relation between the conjugate foci A and A′, and the principal focal length *f*, is given by the equation—

$$\frac{1}{f} = \frac{1}{A} + \frac{1}{A'}$$

The action of a lens on rays proceeding from different points is shown in fig. 9. Now, since any visible object may be regarded as a collection of luminous points, and since the rays from every point are brought to a *corresponding* point on the other side, it is clear that an image of the luminous or illuminated body will be formed on the opposite side of the lens, and can be received on a suitable screen and thus made visible.

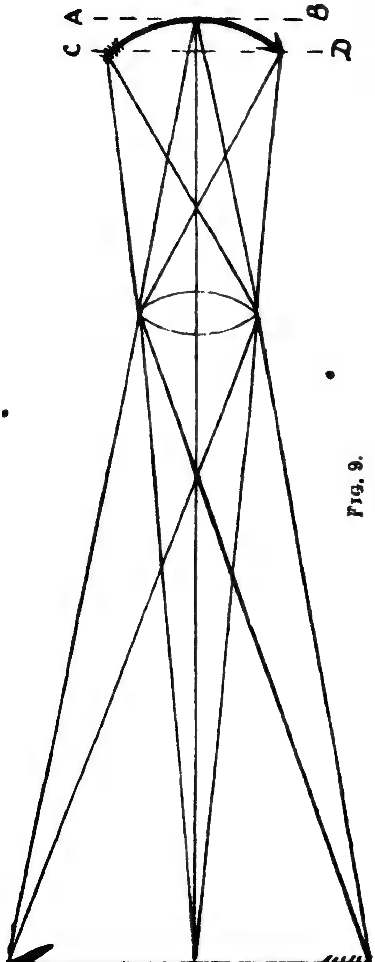

Fig. 9.

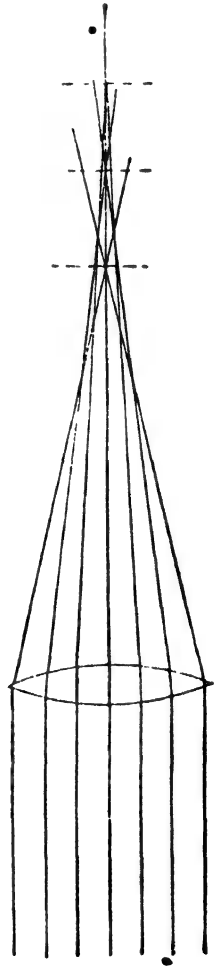

Fig. 10.—Spherical Aberration.

It is clear, also, from the direction of the rays, that the image will be upside down.

The diameter (length or breadth) of the image is directly proportional to the focal length of the lens; for example, double the focal length, double the diameter of the image, and *vice versâ*. The area of the image is proportional to *the square* of the focal length of the lens. For the same lens the diameter of the image is inversely proportional to the distances of the object from the lens: double the distance, half the diameter of the image, and *vice versâ*. The *area* of the image is inversely proportional to *the square* of the distance of the object from the lens.

FIG. 11.—Meniscus Lens.

If the images produced by lenses were absolutely perfect, each point of the object would be represented by a point in the image. This perfection is not realised, and points in the object are represented by minute circles in the image; the optician's aim is to make his lenses as nearly perfection as he can, and the photographer's object is to use them in such a way that, if a sharply defined image is required, the circles representing the points shall be so small that the eye does not detect the difference.

The action of a single spherical lens is never perfect, as shown in figs. 6 and 8. The amount of refraction is greater at the edges than in the middle, and, consequently, rays passing through the edges of the lens are brought to a focus nearer to the lens than the focus of the rays that pass through the middle (fig. 10). It follows that, wherever we place the screen to receive the image, each point of the object is represented by a nebulous disc, and these overlap, giving a blurred image. Since this defect arises from the spherical form of the lens, it is termed *spherical aberration.* It is reduced by giving to the lens a meniscus form (fig. 11) instead of the biconvex form, but can only be corrected by combining two or more lenses of different glasses and different curvatures, sometimes with an air space between at least one pair of them.

In some of the most perfect modern "single" lenses, which are really composed of three, four, and even five

separate lenses cemented together, the two outer faces of the lens are practically concentric. With an imperfectly corrected lens, spherical aberration can be reduced by placing in front of the lens a *stop* or *diaphragm* (an opaque screen with a circular hole in it), so that the rays from any point are allowed to pass only through the middle or the edges of the lens, and not through both (fig. 12).

Further difficulty arises from the curvature of the field of the lens, or, in other words, the image of a flat object is not formed on a plane surface, but on a spherical surface, as indicated in fig. 9. It follows that, if we move a screen (*e.g.* the ground glass of the camera) to the position A B, the middle part of the image will be well defined, whilst the edges will be blurred; but if we move it to C D, the edges will be well defined and the middle blurred. By taking a position between the two, and using a stop or diaphragm, we can reduce the blurring so much that it becomes imperceptible; but this involves cutting off a large part of the light, and therefore necessitates long exposures.

In addition to spherical aberration, lenses have a defect known as *chromatic aberration.* Ordinary white light is made up of rays differing from one another, and producing different colour sensations, such as red, orange, yellow, green, blue, violet, when they fall *separately* on the eye. Now these different rays are not equally refracted;

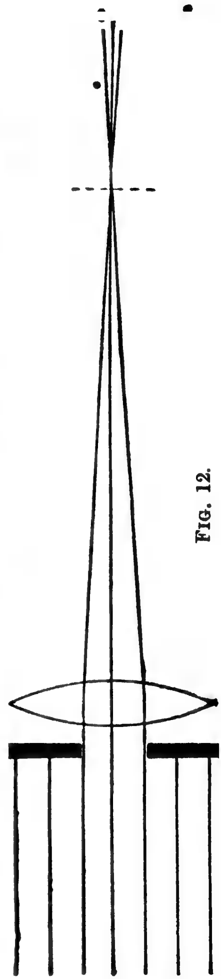

FIG. 12.

the blue and violet rays are brought to a focus nearer to the

lens than the orange, yellow and green rays. The orange, yellow and green rays give us the brightest illumination, whilst the blue and violet rays give feeble illumination. Consequently, when an image is in focus to the eye, the orange, yellow and green rays are in focus, but the blue and violet rays are not. The blue and violet rays, however, are the rays that affect the photographic plate, and hence the image on the plate would be blurred, although the visible image, on the screen (produced chiefly by green, yellow and orange rays) was well defined. Fortunately, different kinds of glass behave differently in this respect, and by cementing together lenses of different forms, consisting of different kinds of glass, chromatic aberration is removed, and the different rays are brought into focus together. Lenses of this kind, in which the visible image and the photographic image coincide, are termed *achromatic* lenses, and these only are suitable for photography.

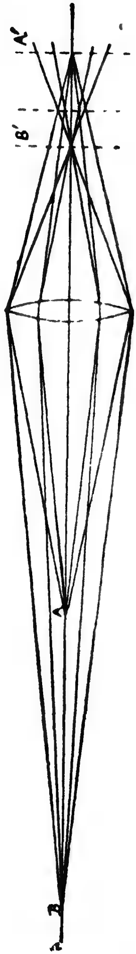

FIG. 13.

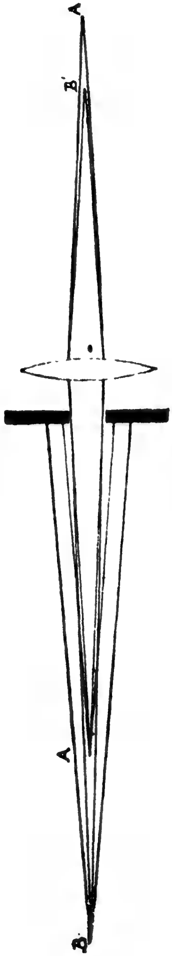

FIG. 14.

Another important point is that the position of the sharply defined image of an object depends on the distance of the object from the lens (see fig. 8). Consequently, if we place the screen so that a near object at A (fig. 13) is well defined, the image of a distance object at B will be blurred, and *vice versâ*. Here, again, the use of a stop removes the difficulty, and, by cutting down the pencil of light, reduces the blurring until it becomes imperceptible (fig. 14).

The lenses used by photographers are, as a rule, either *single lenses* or *doublets*—the latter term in its widest sense meaning lenses composed of two single lenses, or their equivalents in groups of lenses, with the stop between them.

The single lens (which is always compound in structure, and made of two, three, or more parts cemented together) generally has a meniscus form, or in the later forms of lenses has its two outer surfaces almost, if not quite, concentric, and is fitted into a brass or aluminium mount with the stops in front. These stops are best arranged as an *iris diaphragm*, which consists of a number of thin plates of metal so arranged that by rotating a ring that is fitted round the edge the opening can be contracted or enlarged. Sometimes the stops are arranged on a rotating wheel. In the form known as Waterhouse diaphragms, each stop is cut in a separate piece of metal, and the latter drops into a slot cut in the lens mount. Single lenses have few reflecting surfaces, and give very brilliant images; they are excellent for landscape work, but have the defect that, when used with a stop, they give a distorted image, and hence cannot be employed for architectural or similar subjects. The distortion takes the form of curvature of the straight lines near the edges of the picture. When the stop is in front of the lens the image of a square becomes barrel-shaped (A); but if the stop is behind the lens, it is cushion-shaped (B) (fig. 15). The latest forms of single lenses have a flat field, and the distortion caused by the stop is minimised.

Rectilinear lenses are free from this defect. They consist of two single lenses or groups of lenses, placed at a suitable distance apart, with the stops between. We thus have a lens with the stop behind giving cushion-shaped distortion, and a second similar lens with the stop in front giving barrel-shaped distortion to an equal extent. It follows that the one

distortion neutralises the other, and the image is free from distortion.

Aplanatic or Symmetrical Doublets consist of two similar single lenses, or groups of lenses, known respectively as the *front combination* and the *back combination*, arranged in the manner just indicated, with the stop midway between them. If the single lenses are properly constructed, and are arranged at the proper distance, they not only give non-distorted or orthoscopic images, but the spherical aberration is so far reduced that they give sharp definition over a considerable area even when used with a large aperture, and hence they allow of very short exposures being given. Unless, however,

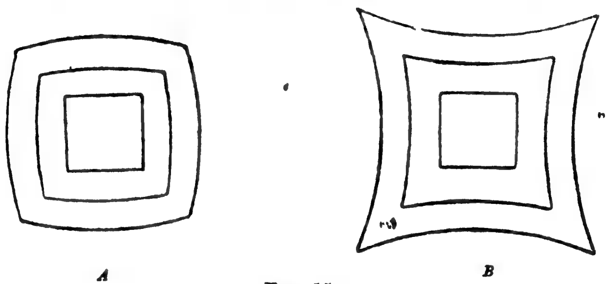

FIG. 15.

each of the single lenses is separately *anastigmatic* (see below), the aplanats or symmetrical doublets do not give a perfectly flat field, and there are defects of definition (astigmatism) in those parts of the image farthest away from the centre. The front or back combinations of the aplanats can be used separately as single lenses, and have a focal length approximately double that of the doublet, so that each lens of this type in practice serves as two lenses, a single lens and a doublet.

Anastigmatic or *stigmatic* lenses (the two words mean the same thing) are brought to such a degree of perfection that the image field, instead of being curved (fig. 9), is flat, and the outer parts of the image are as well defined and free from distortion as the central parts. When the object to be

photographed lies in one plane, an anastigmatic lens will, with a very large aperture, form an image of it which not only lies in one plane (*e.g.* on the photographic plate), but is sharply defined all over that plane. The production of lenses of this kind was only made possible towards the end of the nineteenth century by the introduction of the special kinds of glass known as Jena glass. Single lenses can be made anastigmatic, but even then they are generally employed in the form of doublets, so as to admit of the use of large apertures. Anastigmatic doublets may be symmetrical, and are then known as double anastigmats, aplanatic anastigmats, or symmetric anastigmats. In such cases the front and back combinations are cemented lenses, and each can be used as a single lens, and is anastigmatic. The *Planar* is a symmetric anastigmat which can be used with a very large aperture, and serves for taking portraits as well as for other purposes; but the front and back combinations are not cemented lenses, and are not intended to be used separately as single lenses.

What are known as "Satz anastigmats," "convertible anastigmats," or "convertible protars" are single cemented anastigmatic lenses, which can be used with moderately large apertures as single lenses, but, when combined in suitable pairs, form doublets which can be used with much larger apertures, and, although not strictly symmetrical, have in practice almost all the advantages of the aplanats or symmetrical lenses, in addition to being anastigmatic. If a photographer has four such lenses of different focal lengths, he not only has four single lenses, any one of which can be used separately, but he can combine them so as to produce six different doublets, thus giving him a battery of ten lenses in all.

There are, however, several anastigmats (some of them sometimes also called "protars") which are not symmetrical, and the front and back combinations of which cannot be used separately. Whilst they are equal in performance to the others, and are distinctly cheaper, the fact that they serve as only one lens lessens their general utility. The *Unar* is a lens of this type, very simple in construction, and capable of being used with a very wide aperture. It is therefore well adapted for hand cameras and instantaneous work in general, and also

for studio portraiture, though the available aperture is not so large as that of the *Planar*.

The *Dallmeyer Stigmatic Lens*, Series II., is anastigmatic, but is not symmetrical. It is, however, so designed that the front and back combinations can be used separately as single lenses; and since they differ considerably in focal length, they really make, with the complete lens itself, a set of three available lenses. The Stigmatic Lens, Series III., is a cheaper and simpler form, working with a slightly smaller aperture, the front and back combinations not being available as single lenses.

The Cooke Lens is an anastigmatic lens of a special type, and consists only of three lenses, not cemented and not capable of being used singly. It works with a large aperture, and is suitable for a wide range of work, including both hand-camera and architectural subjects.

All anastigmats, as already stated, give sharp definition on a flat field over the whole of the image, provided that the object lies in one plane; but if different parts of the object lie in different planes, as in street views, architectural interiors, and landscapes, they require to be stopped down somewhat in order that the objects in different planes may all be sharply defined. Since, however, the marginal parts of the image are so well defined, considerably less stopping down is necessary than with lenses of the older types.

Portrait Lenses are rectilinear lenses of special construction which are not usually aplanatic, but may be anastigmatic, though many of them are not. They are designed to give, when used with a very large aperture, a brilliant image, very sharply defined over a limited area, of an object lying approximately in one plane. They are of little use for anything but their special purpose of taking portraits; but they can be employed for enlarging and also as the front lenses of optical lanterns. The Planar and Unar lenses have such large apertures that they can be used as portrait lenses as well as for general purposes. There is also a Stigmatic Portrait Lens which gives good definition over a wider angle than the ordinary portrait lenses, and therefore is especially valuable for use in short studios or for portraiture in ordinary rooms.

Telephotographic Lenses.—In order to obtain a fairly large

image of a very distant object under ordinary conditions, a very long focus lens must be used, and consequently a very long extension of camera, which is always inconvenient and often impracticable. The telephotographic objectives, devised independently by Dallmeyer and by Miethe, are designed to get over this difficulty by giving a large image with a moderate extension of camera bellows. They consist of a negative or diverging lens, which is placed behind the ordinary lens, and magnifies the image formed by it. The degree of magnification depends on the focal length of the negative lens, its distance from the positive lens, and the extension of the camera bellows; and the two latter magnitudes can be adjusted so as to meet a variety of cases. For full particulars reference should be made to *Elementary Telephotography*, by Ernest Marriage, or to the very complete treatise on *Telephotography* by T. R. Dallmeyer. These lenses make it possible to obtain photographs of distant objects, such as mountain summits, which could not be secured without their aid; and they are especially valuable when dealing with architectural detail, with living birds and other animals in their natural surroundings, and a variety of other subjects. When used for long-distance objects it is of course essential that the atmosphere should be very clear and the lighting satisfactory. The presence of even a very slight haze necessitates the use of a chromatic plate and a moderately deep yellow screen.

A defect that may be met with in all classes of lenses is the *flare spot*. This is a circular patch of light in the centre of the image, producing in the photographic negative a corresponding patch of abnormal opacity; the usual cause is an improper position of the stop, and a lens showing this defect should be at once returned to the maker. A *flare spot* is rarely met with in an ordinary rectilinear lens, but is almost always recognisable if an attempt is made to use a small stop with a portrait lens.

When selecting a lens for the purpose of photographing a particular subject, we have to keep in mind the size of the image that will be formed, and also the quantity of subject, so to speak, that will be sharply defined on the plate that we are going to use. The quantity of subject included in

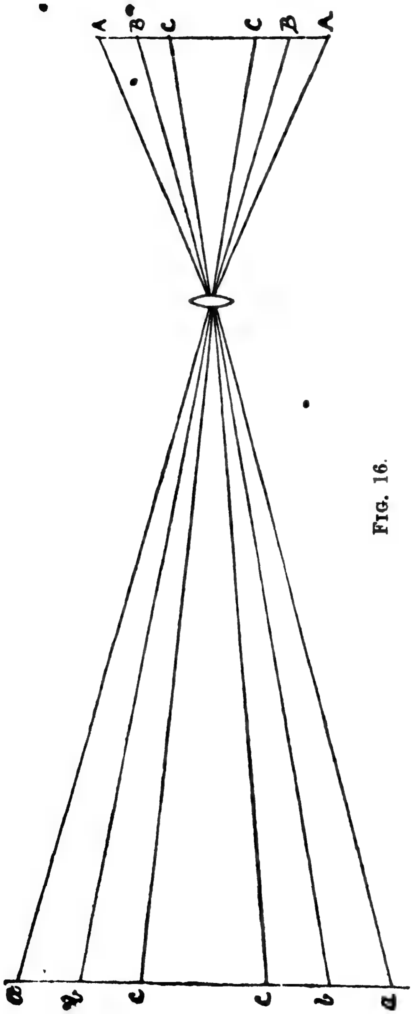

FIG. 16.

a given plate is generally spoken of as the *angle of view*, and lenses are often called *wide-angle* lenses and *narrow-angle* lenses. These terms are purely relative, and are very commonly misused and misunderstood.

The *size of the image* and of its parts, as already stated, depends only on the focal length of the lens and the distance of the object from the lens.

For a given focal length the *angle of view* depends partly on the form of the lens, and partly on the diameter of the stop used. As a rule it is relatively greater with lenses of short focus than with those of long focus. With a large aperture the image is sharply defined at the centre, but the definition falls off continuously towards the edges; by gradually decreasing the opening of the stop a greater and greater amount of the subject is sharply defined — *i.e.* the smaller the stop the

wider the angle of view with any particular lens. There is, however, always a maximum limit, determined by the form of the lens.

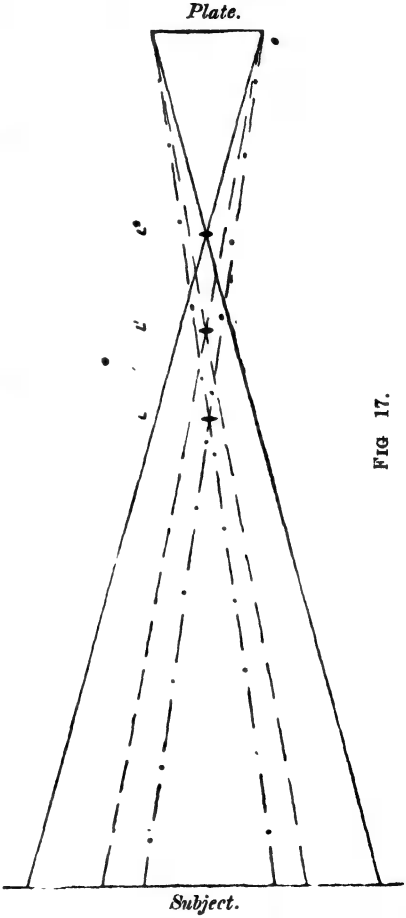

FIG 17.

Suppose we have a lens of a given focal length and with a given aperture (fig. 16), capable of giving a sharply defined image over the area *CC*, and therefore including a quantity of subject, *cc*, by inserting a smaller stop we may get a sharply defined image over *BB*, and therefore including a greater quantity of subject, *bb*; whilst a still smaller stop will give us definition over *AA*, and include a quantity of subject, *aa*. It is clear that the angle of view continually increases. Similar effects can be produced by altering the form and construction of the lens, without altering the aperture of the stop.

With a lens of a given focal length it is obvious that the angle of view partly depends on the size of plate used. If we use a plate of the size *CC* (fig. 16) when the lens is capable of covering one

of the size *AA*, we shall not utilise the full power of our lens, and we shall only include the same angle of view as we did when the lens was not capable of covering more than *CC*. It is only when we use a plate capable of receiving the whole of the image *AA* that our lens becomes really a wide-angle lens. In other words, one and the same lens may be a narrow-angle lens if used with a small plate, and a wide-angle lens if used with a large plate.

With a particular size of plate the angle of view depends on the focal length of the lens, and is wider the shorter the focal length, provided always that the lens is capable of covering the whole of the plate. This is illustrated in fig. 17; L, L^1, and L^2 being lenses of different focal lengths. The angle of view increases as the focal length decreases, but it is obvious that the dimensions of the separate images will decrease at the same time.

If only one lens can be purchased it should be of the rapid rectilinear type, and should have a focal length not less than the length of the diagonal of the plate; that is, not less than 5 inches for a $\frac{1}{4}$-plate, $7\frac{1}{2}$ inches for a $\frac{1}{2}$-plate, 10 inches for a whole-plate. It is, however, a great advantage to have several lenses of different focal lengths. A short-focus rectilinear lens of good covering power is indispensable if much architectural work is to be done.

Lenses should be used with considerable care; they should be kept in a dry place in bags of chamois leather, and should be dusted from time to time with a camel's-hair brush, each of the components of a doublet being unscrewed from the barrel for this purpose. If necessary, they may be wiped with a wash-leather slightly wetted with methylated spirit, but it must be perfectly free from grit.

CHAPTER III.

PLATES AND FILMS.

THE sensitive material most commonly used is a dry thin film of an emulsion of silver bromide with gelatine, spread as evenly as possible on a sheet of glass. A transparent flexible film of celluloid, insoluble gelatine, etc., may be used in place of glass as a support for the sensitive material, and the difficulties in the way of making a perfect transparent film have now been largely overcome. The substitution of a flexible film for glass does not involve any very marked differences in the mode of manipulation.

The sensitiveness and fineness of grain of the emulsion varies greatly, and depends on the manner in which the emulsion has been made; as a rule, the more sensitive the emulsion, the coarser the grain, or, in other words, the larger the particles of the silver bromide embedded in the gelatine.

The Ilford plates for negatives are made in six degrees of sensitiveness, namely:

Ordinary (*Yellow Label*), sufficiently rapid for very short exposures under favourable conditions, are the best plates for *all-round work.*

Empress (*Salmon Label*), are double the speed, requiring only short exposures, even when the conditions are not the best possible, and therefore suitable for use in hand cameras. The best plate also for general studio work.

Special Rapid (*Red Label*), requiring only about one-quarter the exposure necessary for the *Ordinary* plates. These are intended either for studio work or for outdoor exposure, if care be taken not to over-expose.

Monarch Plates (*Purple and Gold Label*), requiring about one-half the exposure of the *Special Rapid* plates. These are adapted for all work in which extreme speed is wanted.

Half-tone Plates (*White and Red Label*), requiring one and a half times the exposure of *Ordinary* plates, and intended for photo-mechanical work in half-tones.

Process Plates (*Black and White Label*), requiring about seven times the exposure of the *Ordinary* plates. They are intended for the production of negatives for photo-mechanical processes, the copying of drawings and other line subjects, and the like.

Ilford *Empress and Special Rapid Films* correspond strictly with the same brands of plates; but the emulsion is supported on celluloid instead of glass.

The plates are packed in fours, each pair being face to face and separated by strips of card along their long edges. Each box, except with the large sizes, contains one dozen plates.

The plates will remain good for a long time, provided that they are not exposed to light, and are kept dry and in a pure atmosphere; they must on no account be kept in a damp place, nor on high shelves in a room where gas is burnt, nor in any other position where they can come into contact with products of combustion or any other gases except pure air.

The boxes of plates must be opened only in the developing room, in a feeble orange light, and the plates must be handled with great care. In order to fill the plate-holders, or dark slides, the latter are opened and the inside carefully dusted; the plates are then taken from the box, any dust removed from the surface by *very lightly* and quickly brushing with a perfectly clean, broad, flat camel's hair brush, and the plates put into the holders with the sensitive surface (easily recognised by its dull appearance) towards the shutters—*i.e.*, downwards as the dark slide lies open on the table. The partition is then fixed in its place and the slide closed. During this operation the plate should be exposed as little as possible, even to the light from the developing lamp; the plate should be held by the edges only, and the fingers must not be allowed to come into contact with the sensitive surface.

Sizes of Plates.—English photographic plates are cut to certain recognised conventional sizes, their names, and dimensions in inches, being as follows:—lantern size, $3\frac{1}{4} \times 3\frac{1}{4}$; quarter-plate, $4\frac{1}{4} \times 3\frac{1}{4}$; five by four, 5×4; half-plate, $6\frac{1}{2} \times 4\frac{3}{4}$; seven-and-a-half by five, $7\frac{1}{2} \times 5$; whole-plate, $8\frac{1}{2} \times 6\frac{1}{2}$; and larger sizes, such as 10×8, 12×10, and 15×12, which are named according to their dimensions—*e.g.*, fifteen by twelve.

The larger the plate, the greater the weight of the apparatus to be carried in the field, and the greater the expense, not only in the outfit, but also in materials. Half-plate is the smallest size that gives a picture large enough to be framed by itself, and the beginner is recommended to start with this or with a larger size. When a hand-camera is used, however, the

quarter-plate will often be found a very convenient size. The half-plate gives a very good ratio of length to breadth, and is suitable for all classes of subjects; $7\frac{1}{2} \times 5$ is, however, somewhat better when much landscape work is done, and is especially good for marine and cloud subjects. Whatever size of plate is selected, it is useful to remember that the dark slides can be fitted with carriers capable of holding any of the smaller sizes; for example, quarter-plates or lantern plates can be used in a half-plate camera.

CHAPTER IV.

THE PICTURE.

ONE photographer will be satisfied if he merely makes accurate representations of the objects before him; another will desire to make the representation as pleasing as possible by introducing as much of the pictorial element as the circumstances will permit; a third will regard the pictorial element as the most important factor, and will select only such subjects as lend themselves to pictorial treatment.

Photography is undoubtedly of the greatest service and value as a means of making accurate representations of landscapes, architecture, animals, flowers, etc., quite apart from any pictorial considerations; but it is obviously desirable that the representation, whilst accurate, should be as pleasing as possible. In order to secure this end, and still more when the pictorial quality is the first consideration, the photographer must have some knowledge of the principles of picture-making—the principles of artistic selection, composition, and arrangement of light and shade—that are found, on examination, to underlie the construction of the vast majority of those pictures, the excellence of which is established by a consensus of opinion on the part of those qualified to judge. A knowledge of the principles of artistic construction will no more make a man an artist than a knowledge of grammar will make him an elegant writer; but no writer, if he wishes to be read, can neglect the established construction of the language that he uses, and no picture maker can afford to neglect the artistic principles that have been developed and adopted by the greatest amongst his predecessors.

Every method of graphic art is bound by certain limitations peculiar to itself, and subjects quite suitable to one method are inappropriate to another. A photograph professing to represent an incident that took place before photography was invented is an anachronism and a sham; and all shams are bad Art. The more sacred of the human emotions, such as deep grief, may fitly be portrayed by the painter, who makes free use of his imagination, but they are outside the proper scope of photography. We either feel that the intrusion of the camera was in very bad taste, or we know that the photograph is merely a transcript of a more or less successful piece of posing and acting; and, even in the latter case, we are unable to avoid feeling that the subject and the method are incongruous.

A picture to be good must have unity; it must have one principal object or idea—one *motif*, as it is termed—and one only. It must be so constructed and arranged as to bring out this *motif* in the clearest and most emphatic manner possible, so that the beholder is not left in doubt as to why the picture was made. The object of the arrangement should be to emphasise the principal object and to subordinate the others, so that, whilst giving the variety that is essential to a pleasing picture, they do not distract the attention by claiming equal prominence with what should be the principal object. This emphasis and subordination is secured by proper arrangement of lines and forms, of light and shade.

Examination shows that objects acquire a certain degree of prominence merely from the position that they occupy in a picture. The weakest position is the centre of the picture, and the strong points are those the distances of which, from opposite sides of the picture, are in a simple ratio, such as 1 to 2, or 2 to 3. If we imagine the picture to be intersected by lines as in fig. 18, an object placed along one of the lines, AA, BB, CC, or DD, will attract a certain amount of attention merely by virtue of its position. The strongest points of all are those where two of the lines intersect, and the middle points (*a*) of the rectangles into which the picture is regarded as broken up are strong points of a secondary order, with the exception of the middle rectangle, the central point (*b*) of which is the weakest point of all.

This principle of position, like all the other principles, is

not to be slavishly adhered to, but will be found to be a very great help to satisfactory composition. It is a good plan to rule pencil lines across the ground glass of the camera in the manner shown in the diagram. The horizon of the picture should very rarely run across the middle, but should be about one - third from the bottom, or one-third from the top; the principal object should run along or over one of the lines, AA,

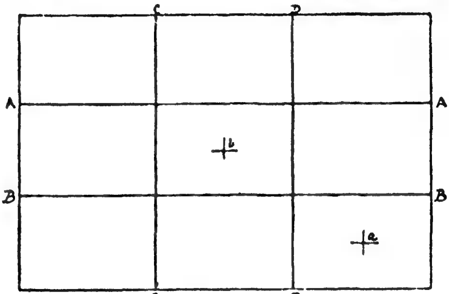

FIG. 18.

BB, CC, or DD, and as a rule should cross one of the intersections of the vertical lines with the horizontal, the exact position of the principal object, as well as that of the horizon, being determined by considerations of balance.

In order to secure variety, the picture must not be symmetrical either in composition or light and shade about a middle line, whether horizontal or verti-

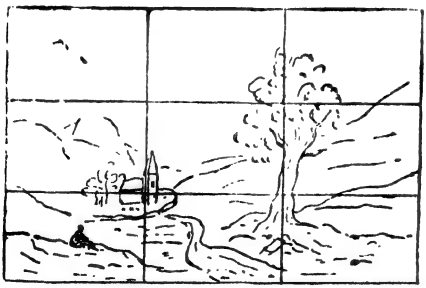
FIG. 19.

end, and also with a view to prevent distraction of the attention, no prominent objects should occupy similar positions on opposite sides of the picture. For example, if a prominent object lies about the intersection of DD with BB, another prominent object should not lie about the intersection of CC with BB. The diagrammatic sketch (fig. 19), the idea of which is taken from

H. P. Robinson's "Picture Making," illustrates the manner in which the principle is carried out.

For the sake of variety a building should not be placed exactly in the middle of the picture, but more or less to one side, and should not be taken directly from the front, but at an angle. A street view should have the vanishing point towards one side (fig. 20), and not in the middle (fig. 21). In a word, avoid anything in the shape of a pronounced formal or geometrical arrangement.

FIG. 20.

Light and Shade in outdoor work are not under the control of the photographer, but by choice of position, of time of day, and even of time of year, he can select the natural arrangement of light and shadow that is best suited to his subject. If the sun is directly behind the camera the lighting will be very flat, and there will be practically no shadows; if the sun is directly in front there will be nothing but shadow. The results are unsatisfactory, too, as a rule, when the direction of the sun's rays is exactly at right angles to the line of direction of the camera. The best results are generally obtained with slant lighting, the sun being behind the camera to the right

FIG. 21.

or left, or in front of the camera to the right or left. The value of shadow in a picture is very great, and beautiful effects are obtained with the sun somewhat in front; but care must be taken to prevent the sun's rays from shining directly into the lens, by using a shade or by placing the camera, if possible, in the shadow of some object. When the sun is behind the camera, greater relief is obtained by taking the view from the shadow side, as indicated in fig. 22, and this course is especially to be recommended in dealing with architectural subjects.

Whilst securing variety, great care must be taken not to lose *balance*, an indispensable quality in a picture. Strong lines running in one direction must be balanced by strong lines in an opposite direction; diagonal lines must be balanced

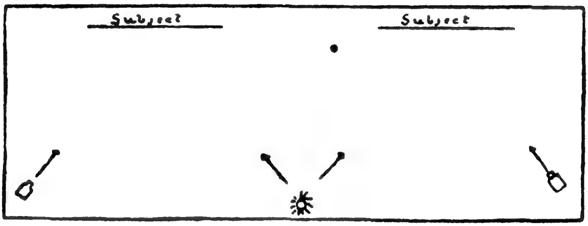

FIG. 22.

by vertical or horizontal lines, or by diagonal lines in the opposite direction; masses of light and shade in one part of the picture must be balanced by masses of light and shade in the other parts. Want of balance gives a sense of insecurity, and the impression that the picture is falling to pieces. This effect can be utilised when it is wished to represent dangerous crags and the like, but in other cases absence of balance is fatal to the success of the picture. Balance in some cases depends on the position of the principal objects; in the case of a large building, tower, etc., an important factor in the balance is the fact that more of the picture is in front of the building than behind it (fig. 23), and this principle should, as a rule, be carefully observed.

Examination of a number of satisfactory pictures will show that in almost every case they are built up of wedge-shaped

masses, the points of the wedges being supported by wedges running in the other direction, or by vertical masses. When the principal wedge coincides roughly with the diagonal of the picture we have what is known as diagonal composition (fig. 20). Where the wedge form becomes very pronounced, as it frequently does when photographing a river and its banks, the proper support of the apex of the wedge requires careful attention (fig. 24).

FIG. 23.

Breadth is also essential to good pictorial effect; it may best be defined by saying that it is the opposite of spottiness. A picture has breadth when the different parts form one harmonious whole, each part being dependent upon the others, all subservient to the principal object, and all helping to emphasise the *motif* of the picture. Breadth is wanting if the different parts of the picture fail to hang together, and each part seems independent of the rest. The point of view should be so chosen that the lines run in broad sweeps, and the various objects are arranged in a few groups broadly defined, but not detached and independent. Attention to the lighting is quite as important as care in the arrangement of ...; nothing destroys breadth more completely than the

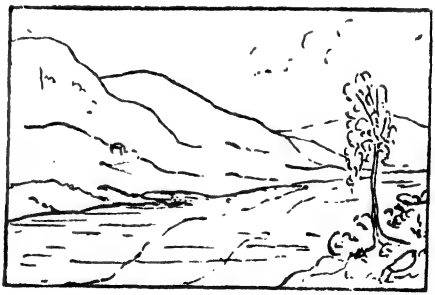

FIG. 24.

scattering of high lights all over the picture. As a rule there should be comparatively little high light, and the greater part of the picture should consist of half-tones and shadow. When scattered lighting cannot be avoided it is a great help to place among the lights, at some strong point in the picture, an object which brings into juxtaposition the highest light and the deepest shadow in the picture: for example, a child in a black dress with a white pinafore. This will generally pull the whole composition into harmony in a quite wonderful way. A similar effect is obtained by placing a dark object in front of a bright background (*e.g.*, a dark boat on a patch of strongly lighted water), or a bright object against a dark background (*e.g.*, a girl in a white dress against a black rock or a dark mass of hedge or trees).

In dealing with figures be very careful to avoid spottiness or harshness in the lighting. The pose of the figure or figures

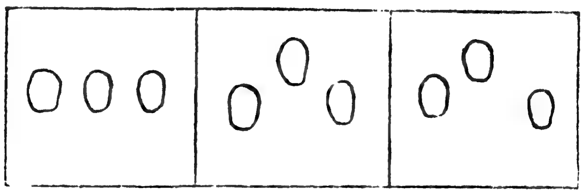

FIG. 25.

should be such that the lines of the limbs not only balance amongst themselves, but are also in harmony with the lines of the background and accessories. When dealing with more than one figure, symmetrical arrangement ("heads in a row" and the like) must be avoided; three heads, for instance, should be arranged in an irregular pyramid, and not in a regular pyramid or in a straight line (fig. 25). Satisfactory compositions in which figures play a principal part will almost always be found to be made up of a series of pyramids, one supporting the other; these pyramids should be irregular in form, and care must be given to the proper balancing of the composition. Groups with a large number of figures should

never be symmetrical about the middle; the figures should not be placed in strongly marked horizontal lines, and an effort must be made to secure as much variety as possible, both in the grouping and in the attitudes of the figures.

Remember always that the statements made in this chapter are not rules to be slavishly followed; they are simply enunciations of some of the more important principles of construction that are found to underlie the arrangement of pictures that every one regards as satisfactory. A true artist is not a slave to these principles, but is master of them, and utilises them for the more satisfactory realisation of his own ideas. Read carefully "Pictorial Effect in Photography," and "Picture-Making by Photography," by H. P. Robinson, "Sketching from Nature," by Tristram Ellis, and Burnet's "Essays on Art." Examine systematically the construction of every picture that pleases you, and apply the same treatment to all natural views that excite your admiration. Think for yourself, and endeavour to put your own thoughts and feelings into your pictures.

CHAPTER V.

IN THE FIELD.

HAVING acquired, from the study of good paintings, drawings, and photographs, some acquaintance with the principles of picture-making, we are ready to go into the field with our apparatus (the dark slides being filled with plates) in order to put these principles into practice.

Take care that you leave no essential part of your apparatus at home; the tripod head and screw, for instance, are not at all unlikely to be forgotten. It is a good plan to have a list on the inside of the lid of the camera case, and to make sure before starting out that every article in the list is in its proper place in the case.

After selecting an object or view, which at first should be of a simple character, with broad masses of light and shade, we

proceed to set up the tripod. The camera is then screwed on the tripod, and the lens inserted in the camera front. Take care that the camera is level in both directions, and that the lens points towards the object to be photographed. The camera should be fixed on the tripod in such a manner that the lens is over one of the legs, and the photographer, whilst focussing, stands between the other two legs of the stand, as shown in fig. 26. With the head under the focussing cloth, rack out the camera until the *inverted* image on the ground glass becomes well defined. You will observe that, as you rack out, the definition will become better and better up to a certain point, but if you continue to rack out beyond this the definition will again get worse and worse.

FIG. 26.

If you find that the whole of the subject is not visible on the screen, you must either move the camera farther back from the subject, or, if this cannot be done, you must employ a lens of shorter focus. If the image is too small, and more than the subject you wish for is seen on the screen, move the camera nearer to the subject, or use a lens of longer focus. With some practice you will soon be able to judge at what distance to place your camera from a particular view, and which lens will be most suitable. Much help in this respect is obtained by the use of a *view-meter*, of which there are several forms, but nothing is simpler, or, on the whole, more useful, than a small pocket tape measure. This must first be graduated in the following way:—Set up the camera in front of a view with a number of well-marked vertical lines, such as a row of houses, a belt of trees, or a line of fencing; observe carefully which objects are at the extreme edges of the screen, and then, standing close by the camera and holding your arms straight out in front of you, with one end of the tape held between the thumb and forefinger of one hand, move the thumb and forefinger of the other hand along the tape (which is kept stretched horizontally) until the hands, at arms' length, point respectively to the two outermost objects seen on the screen. Now mark on the tape the position of the second hand from the end, and repeat the process with every lens that you have. Afterwards, when you have selected your subject and view-point, hold

the tape in the manner described, so that the hands point to the extremities of the view that you wish to secure, and the position of the second hand along the tape will tell you which lens to use.* If you have only one lens, and wish to find at what distance to place your camera in order to include a particular subject, hold the proper length of tape out in front of you, and advance or retire until the view is just included between your hands, and set up your camera at that distance.

Having got the distance, with the camera levelled and the image focussed on the ground glass, examine the image carefully in order to see whether the different objects occupy suitable positions on the screen. If the principal object is too much to one side or the other, loosen the baseboard screw, and rotate the camera until a good position is obtained. The composition, balance, and general appearance of a picture can often be greatly altered by moving the tripod a few feet to the right or left. If there is too little foreground, lower the lens; if there is too much foreground, raise the lens. Should the result be still unsatisfactory, move the tripod leg so as to raise or lower the camera. If, when the lens is raised to the highest point that the camera front will allow, there is still too much foreground—which will frequently happen in the case of architectural views at close quarters—the camera must be tilted backwards, taking care, however, that the base of the focussing screen remains level. This tilting introduces a serious distortion, and parallel vertical lines are no longer parallel on the screen, but converge towards the top of the picture (fig. 27). In a purely landscape subject this distortion might not be recognised, but an architectural subject would be completely spoiled. The remedy lies in the use of the swing-back, which should be swung out from the bottom until the plate is brought back to a vertical position, the camera and lens remaining tilted. This rule should always be remembered: *No matter how much the camera may be tilted, the base of the plate must*

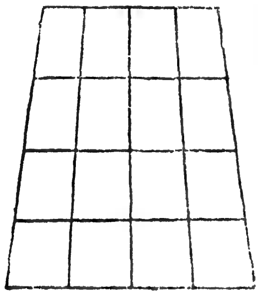

FIG. 27.

always be horizontal and the sides of the plate vertical.* Obviously, if you are standing on an elevation, and it is necessary to tilt the camera downwards, the swing-back must be swung out from the top. The alteration of the swing-back will throw the picture out of focus, and the screen must be moved nearer to the lens; it will also be found that, when the swing-back is used, a smaller stop will be required to get the whole of the image sharply defined. There is another use of the swing-back that is sometimes of great value in instantaneous work, since it enables near and distant objects that are in different planes of the picture to be brought into focus together, even when the lens is used with a large aperture. Take, for instance, a sea view with breaking waves in the foreground, shipping in the middle distance, and clouds in the distance. The image of the clouds will be nearest the lens, the image of the shipping farther away, and the image of the waves still farther away (fig. 28). Now (the image being inverted), the first will fall on the bottom of the plate, the second on the middle, and the third on the top; so that, by keeping the camera horizontal and swinging the back

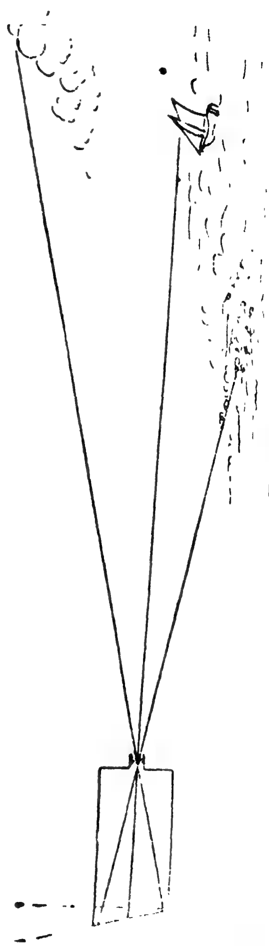

FIG. 28.

* A small plumb or a spirit level should be attached permanently to the swing-back.

(fig. 28), we can get them all sufficiently well defined, even with a comparatively large aperture. The tilt of the back causes a certain amount of distortion, but this is usually not recognisable with such subjects as need instantaneous exposures. A horizontal swing is useful, in a similar way, for getting the near side and the far side of a street in focus together.

After the positions of the camera, swing-back, etc., have been adjusted, the final focussing must be done. You will find that you cannot get distant objects in focus at the same time as those close to the camera. Nor, with a wide aperture, the edges of the picture sharply defined as well as the centre, unless your lens is anastigmatic. Adopt the following method :—Focus, in the first place, upon the principal object, and then try the effect of smaller and smaller stops (if you are using an iris diaphram, slowly rotate the ring so that the aperture gradually closes) until all the remaining parts of the picture are sufficiently well defined to avoid any blurring or fuzziness. Excessively small stops destroy the roundness and atmosphere of the picture, besides necessitating longer exposures, but if enlargements or lantern slides are to be made from the negative, a stop must be used sufficiently small to give good definition throughout the picture. Architectural subjects, especially with elaborate detail, usually require smaller stops than landscapes, unless the detail lies pretty much in one plane.

The focussing being satisfactory, put on the lens cap or close the shutter, turn back the focussing screen and insert the dark slide (taking care to avoid any displacement of the camera), fasten it in its place by means of the catch, and, with the hand underneath the focussing cloth, which should cover the back of the camera, draw out the slide shutter. Wait until any trees etc., are still, and the light and shade are satisfactory, and make the exposure.

The proper time of exposure is always difficult to estimate, and depends upon a number of conditions—namely, the sensitiveness of the plate, the character of the lens, the aperture of the stop, the nature of the subject, the time of year, the time of day, the condition of the atmosphere, the presence or absence of clouds.

Lenses vary greatly in the amount of light that they absorb and cut off, the absorption depending on the colour of the glass

and its thickness. Lenses showing any trace of yellowness when placed on a sheet of white paper should be rejected.

The quantity of light transmitted by a stop depends on the *area* of its aperture, and the best method of defining the efficiency of a particular stop is to express the relation of the diameter of the aperture to the focal length of the particular lens; for example, $f/8$ and $f/16$ mean that the diameter of the stop is, in the first case, one-eighth, and, in the second case, one-sixteenth of the focal length of the lens. The great advantage of this plan is, that all stops expressed by the same number in this system transmit equal amounts of light for equal areas of images, and therefore (neglecting any slight differences arising from the thickness of the lenses) necessitate equal exposures. It does not matter whether the focal length of the lens is six, ten, or fourteen inches; if the diameter of the stop used is one-sixteenth of the focal length (*i.e.*, $f/16$), the exposure will be the same in all three cases. The number f/x is the *intensity ratio* of the stop. With one and the same lens the quantity of light transmitted by the different stops is proportional to the squares of the diameters of their apertures, and, consequently, the exposures required are proportional to the squares of the denominators of the intensity ratios. For example, take the case of $f/8$ and $f/16$: $8 \times 8 = 64$ and $16 \times 16 = 256$; now 256 is four times 64, and therefore with a stop $f/16$, we require four times the exposure that is necessary with a stop $f/8$. In what is known as the Uniform System,* the stops are denoted by numbers which indicate the relative exposures required. The relation between the U.S. numbers and the intensity ratios is shown in the following table:—

U. S. No. . . .	1	2	4	8	16	32	64	128	256
Intensity Ratio	$f/4$	$f/5{\cdot}7$	$f/8$	$f/11{\cdot}3$	$f/16$	$f/22{\cdot}6$	$f/32$	$f/45{\cdot}2$	$f/64$

It will be observed that the diameters of the stops are so arranged that each stop necessitates twice the exposure required with the stop immediately above it. It is easier to recollect the relation between the two sets of numbers if you note that $f/16$ is U. S. No. 16, and $f/32$ is U. S. No. 64. Every one

* Proposed and adopted by the Photographic Society of Great Britain and approved and adopted by the Photographic Convention of the United Kingdom. The stops of all the best English and some of the Continental makers are now arranged according to this system.

buying a lens should take care that the stops are arranged according to this series, and are distinctly marked with the intensity ratio, or the U. S. number, or, better, with both.* In practice, intensity ratios are most frequently used.

It is advisable to make a practice of using only two, or at most three, stops in general work: *f*/8 or *f*/11 for rapid exposures, *f*/16 when there are no very great differences in the distances of the various objects from the camera, and *f*/32 when very near and very distant objects are included in the view. For general landscape work, and for architecture, *f*/32 might almost always be used; it is only when the camera is greatly tilted, and the swing-back is employed to an unusual extent, that a smaller stop will be necessary. To get the best atmospheric effect in landscape, the stop used should not be smaller than is necessary to prevent any decided fuzziness. When, however, small negatives are taken for the purpose of making lantern slides or enlargements, it is scarcely ever advisable to use a stop larger than *f*/32.

Subjects that are of an open character, and have no masses of deep shadow near the camera, require short exposures, whereas subjects with masses of shade in the foreground require long exposures. Where a large proportion of the subject is under trees, as in the case of forest glades or wooded ravines, very long exposures may be required, because the greater part of the light has been filtered through the green leaves overhead; and this holds good even though the camera itself is not under the trees. The colour of the objects also influences the time of exposure; a yellow stone building requires longer exposure than one of white stone, and a red brick building requires still longer. Interiors of buildings always require longer exposures than ordinary outdoor subjects, but they show such great differences, according to the size and position of the windows and the colour of the glass, that the time required varies from less than a minute to three or four hours, or even more. Subjects including a large proportion of sea and sky require, as a rule, very short exposures. Time of exposure in the case of portraits varies enormously, and depends on the conditions of lighting, and also on the character of the effect desired.

* As recommended by the Photographic Convention.

The light is most active, and the exposures required are shortest in June, and on a bright day the activity of the light remains practically the same between 9 a.m. and 3 p.m., and it is equally active in May and July from 10 a.m. to 2 p.m. In spring and autumn longer exposures are required, and in winter the time must be from three to ten times as long as in June, according to the hour of the day. The light is least active in December, and the exposures required become shorter and shorter as we approach June, and afterwards become longer and longer until the maximum is again reached in December. The light increases in brightness from early morning to midday, when it attains a maximum, and then falls off again until sunset, the falling off being considerably more rapid in winter than in summer. In very early morning and towards sunset the exposures are always long, especially if the light is at all yellow.

When the sun is shining, and there are white clouds in the sky opposite the sun, the exposures needed are shorter, other things being equal, than when the sky is perfectly cloudless. A cloud actually in front of the sun of course lengthens the necessary exposure very considerably, and the same is true, in a smaller degree, of light clouds that do not completely obscure the sun. Rain clears the atmosphere of dust, etc., and, other things being equal, less exposure is required after a shower.

It will be clear that the estimation of correct exposure requires considerable judgment and experience. The conditions are never constant, and hence numerical tables are only very approximate, although they afford some assistance at the beginning. Not much help can be obtained from actinometers, because they only measure the intensity of the light where the photographer is standing, whilst what we ought to measure is the intensity of the light reflected from the different parts of the subject. Now and again, and especially when dealing with interiors, they will tell us that the light is much yellower and less active than we should otherwise have believed.

The photographer must learn to rely upon his own judgment, guided by the nature of the subject, with especial regard to the proportion and depth of the shadows; the apparent brightness of the image on the ground glass, and the time of year

and time of day; the character of the light, especially with respect to the presence of clouds—even light ones—between the sun and the earth. Brightness to the eye is not necessarily a measure of activity on the photographic plate, and, as already pointed out, any yellowness—even though slight—in the light, lengthens considerably the time of exposure required. *Sufficient exposure should always be given for the dark parts of the subject*; the brightly illuminated parts will take care of themselves. The exposure given will also depend on the character of the result required: very short exposure increases the contrast, and long exposure reduces the contrast. If, therefore you consider that the contrasts of light and shade in the subject are too strong for pictorial effect, give a longer exposure, and *vice versâ*. For example, a view including whitewashed cottages, or other brilliantly lighted objects, together with foliage, will require a comparatively long exposure if harsh contrasts in the negatives are to be avoided.

The numerical data that follow must be regarded as only approximate, and are intended simply as a help to the beginner. Until experience has been gained, careful notes should be made in the case of every exposure. The stop used, the time of exposure given, the character of the light, the character of the subject, and character of the negative obtained, should be carefully noted.

EXPOSURE IN JUNE, WITH THE SUN SHINING BETWEEN 9 A.M. AND 3 P.M., THE STOP USED BEING *F*/32.

Sea and Sky	¼ to ½ second.
Open Landscape, no deep shadows in foreground	1 second.
Landscape, with heavy shadows near the camera	2 to 4 seconds.
Under Trees	Up to 5 minutes or more.
Interiors	10 minutes to 4 hours.
Portraits and Groups out of doors	2 to 4 seconds.

With stop *f*/16 the exposures will be only one-quarter as long.
With stop *f*/8 the exposures will be only one-sixteenth as long.

The numbers refer to Ilford Ordinary (yellow label) plates.

The second table shows, approximately, the number by which the above exposures must be multiplied, according to the time of day and time of year, and is due to Professor J. A. Scott, of Dublin.

A.M. P.M.	June.	May. July.	April. August.	March. September.	February. October.	January. November.	December.
12	1	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$3\frac{1}{2}$	4
11 or 1	1	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$2\frac{1}{2}$	4	5
10 ,, 2	1	1	$1\frac{1}{4}$	$1\frac{3}{4}$	3	5	6
9 ,, 3	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	4	—	—
8 ,, 4	$1\frac{1}{2}$	$1\frac{1}{2}$	2	3	—	—	—
7 ,, 5	2	$2\frac{1}{2}$	3	6	—	—	—
6 ,, 6	$2\frac{1}{2}$	3	6	—	—	—	—
5 ,, 7	5	6	—	—	—	—	—

The *Ilford Exposure Meter* embodies the above data in the form of a circular slide rule for conveniently calculating the exposures required for various subjects under different circumstances. It is made of aluminium, in such size and form that it can conveniently be carried in the pocket, and it consists of five discs, two of which (the uppermost and the lowest) are fixed, whilst the other three can be rotated about the central axis. The *top disc* has three marks, corresponding to the four brands of Ilford plates used for studio or outdoor work. The *Ordinary* and the *Chromatic* being of the same rapidity, one mark does for both. The *second disc* has graduations representing what are called the *date numbers*, factors which are proportional to the time of year and the hour of the day, and which therefore represent the average photographic activity of the light at the time at which the exposure is being made. The *third disc* is graduated for the intensity ratio (p. 39) of the stop that is to be used. The *fourth disc* is marked with various subjects, and the *fifth disc* carries the times of exposure required. On the back of the bottom disc is a table containing in a modified form the data given in the table above. This table gives the *date numbers* already referred to, which represent the average photographic activity of the light for each hour of the day during each month of the year.

On each of the three movable discs there is an index mark in the form of a small arrow. When using the exposure meter, (1) the second disc is turned until its arrow is exactly opposite to the mark on the top disc corresponding to the kind of plate that is being used; (2) the third disc is then turned until its arrow is opposite the proper *date number* on the second disc; (3) the fourth disc is next moved until its arrow points to the particular stop that is being used. The subjects on the fourth disc will now be opposite the proper exposures, which are marked on the bottom disc. Great care must be taken in moving the third and fourth discs not to displace the disc or discs that are already in position.

The exposure numbers obtained in this way have to be increased if the sky is cloudy, and the photographer must use his judgment as to the amount of increase. In taking interiors he has also, of course, to decide whether he will class the subject as light, dark, or medium.

On Tour.—When away from home special difficulties arise in connection with the transport of new and exposed plates, emptying and refilling the dark slides, repacking the exposed plates, etc.

The dark slides can, as a rule, be refilled, and the exposed plates repacked at night in the bedroom. A portable orange or ruby lamp will be required, and a candle is the safest illuminant to pack with other things. If there is a fan-light over the door, as frequently happens in hotels, take care that no light comes through it into the room from the corridor. Diffused light from the moon, or from street lamps, can, as a rule, be neglected, provided that the lamps are some distance below or away from the window. The blind should, of course, be pulled down, and if the window is provided with curtains or shutters they should be drawn or closed. If it seems really necessary, a sheet or coverlet from the bed may be fastened against the window by means of large drawing-pins, half a dozen of which should be carried in readiness for an emergency; but such a proceeding is rarely needed, and the slides may be quite safely emptied and refilled in a room in which there seems to be a considerable amount of diffused light of the kind referred to, provided that the operation is performed quickly and the plates are not exposed to direct rays from the window,

A corner of the room on the same side as the window is usually the safest place.

If you are likely to need to change plates during the day, it is well to carry some orange or ruby fabric, or paper, and some drawing pins, so that a small window can be effectually screened in a few minutes.

Exposed plates should be packed so that they form practically a solid block of glass. To separate the plates by wedges of cardboard or other material at the sides, or still worse at the ends, greatly increases the risk of fracture. The best method is to use the special boxes devised by Pringle and made by Hare. They are internally of exactly the dimensions of the plates, and the latter are placed in them back to back, face to face, or face to back, strong springs attached to a false end and a false lid preventing any movement and making the plates practically a block of glass. Care must of course be taken that there is no dust or grit between the plates.

The next best method is to pack the plates in pairs face to face, without anything between, after very carefully brushing away any dust or grit. The pairs should be separated by wrapping round them tissue paper somewhat wider than the plates. Each dozen is wrapped in two or three sheets of opaque paper and packed in the original box, or in a metal or wooden box of similar shape and size.

Before each plate is packed a number (corresponding to an entry in the note-book) should be written with a pencil on one corner of the film.

The packets of exposed or unexposed plates should be packed in a stout wooden box, the packages being so arranged that the plates rest on their long edges, and do not lie flat. Tightly packed in this position, so that they cannot shake about, the risk of breakages is reduced to a minimum.

Films are much more easily packed than plates, but it is important to see that they are not subjected to too much pressure, and if they are packed with clothes or the like great care must also be taken that they are not bent.

Development *en route* is not to be recommended, but it is well to develop one or two plates in order to check the exposures. The plates used for this purpose should be duplicate exposures so that they can be thrown away after being developed.

By far the most convenient plan as regards the developer is to make use of the "tabloids," since all the ordinary developers, together with the necessary alkali, can be obtained in this form. Only one measuring-glass and one dish need be carried.

Photographers are often in doubt as to what they may or may not photograph without permission. In this country you may photograph from the high road anything that you wish, but you must not cause an obstruction of traffic. It is desirable not to photograph any private house, even from the high road, without asking permission. In all other cases, where you want to put your camera on private property, permission should be asked, and if the request is made courteously, is usually granted. When you wish to photograph inside a cathedral, or within the precincts, you should apply to the Dean; when you want to photograph the interior of a church, or even the exterior from the churchyard, you should apply to the Rector or Vicar.

Permission is required to photograph in most of the public parks, both in London and in the provinces, and it is not permissible to photograph forts and fortifications.

On the Continent the permissions required vary in different countries. In all cases the neighbourhood of fortifications should be carefully avoided. In some countries permission is required in order to photograph in the streets, and is usually to be obtained from the Chief of Police. Should any difficulties arise, apply to the British Consul or Chargé d'Affaires.

Considerable care is required when passing the Customs Houses, but courtesy and politeness will reduce the difficulties to a minimum. The more freely you offer your packages for inspection, the better, and if you find it difficult to prevent packages of plates from being opened, insist upon being taken to the chief officer. In some places there is a dark room in which plates can be examined. The appearance of photographic goods is now pretty well known at all the principal Customs Houses, and it is a good plan to keep the plates as far as possible in the original boxes with the original labels, and to have a spare box of plates that can be opened if necessary.

CHAPTER VI.

THE DEVELOPING ROOM, OR DARK ROOM.

DEVELOPMENT of exposed plates, and many of the operations of printing, involve the use of apparatus and certain chemicals, and make it necessary to have some sort of a room that can be set apart, temporarily or exclusively, for these purposes. Since this room must be illuminated in such a manner that the light will not injure the sensitive materials, it is often called the *dark room*. Since, however, a considerable quantity of light of the proper kind may, and in fact ought to be used, the term "dark room" is a misnomer, and the term "developing room" is preferable.

A room that can be set apart solely for photographic purposes is a great advantage, even though the room is only small. Work can be done, however, with a little contrivance and arrangement, in a room that is required at other times for other uses, and the kitchen scullery will answer very well if no other place can be obtained; but in the latter case it will only be possible to develop, etc., at night.

A properly appointed developing room should have a water supply, and a sink with a properly trapped waste pipe, a table for supporting the dishes, etc., and some shelves for the bottles containing the various solutions and other chemicals. The sink may be made of stone or earthenware, but is best made of wood lined with lead, and its height should be arranged so that the operator may sit at his work. Some photographers, however, prefer to stand whilst developing, etc., and this necessitates the use of a high sink. The sink should be rectangular in shape and four to five inches deep, the length and breadth being determined by the size of plates employed, and the amount of space at disposal. On part of the bottom of the sink should be placed a false bottom for supporting the dishes; it should consist of a wooden grating, and must be quite level. When only a small sink can be used the dishes must be supported on the table, which should always be placed with its end close to the sink, and the height of the table should be such that its top is level with, or a little higher than, the top of the sink. It is clearly an advantage, from the point of view of

cleanliness, to have the dishes containing the solutions placed inside the sink wherever this is possible. It is convenient to have a piece of flexible indiarubber tube attached to the water-tap and reaching nearly down to the bottom of the sink. A T-shaped upright carrying two taps is a great convenience, and the best form, in any case, is that known as the lever tap.

The shelves for bottles, etc., should be placed in some convenient position close to the sink and work-table, but the exact arrangement of the room will depend on its size, shape, the position of the door, etc. If the room is to be used for drying plates, or if the photographer desires to be able to go in and out of the room whilst work is in progress, some means must be taken to prevent the entrance of light when the door is opened. This is best done by having two doors, with a short passage between, one of the doors being always closed before the other is opened. When this is not practicable, a heavy opaque curtain must be hung outside the door, and it must be of sufficient size to prevent any entrance of light whilst the photographer is opening or shutting the door. The floor of the room should be covered with linoleum or some similar material, and anything in the shape of carpet or matting should be avoided.

FIG. 29.

Where all or any of these facilities cannot be obtained, some makeshifts will have to be put up with. In place of a water supply through pipes, for example, a small cistern or barrel may be supported on brackets against the wall, at some height above the table or sink; and if the plates used are not large it is possible to work simply with a jug. When it is not possible to make an attachment to a proper waste pipe, one of the portable washhand basins on stands, with a large jug or bucket underneath to catch the water, may be used; or even merely a large bucket into which the dishes, etc., can be emptied.

A point of the greatest importance is the proper ventilation of the workroom, and neglect in this matter leads to unpleasant consequences, which are often erroneously attributed to other causes. It is indispensable that there should be an exit for

foul air and an entrance for fresh air, for a small room, if not ventilated, speedily becomes so fouled with products of respiration as to be distinctly injurious to health. If the room contains a fireplace, ventilation is accomplished to a certain extent by the chimney, although no fire is permissible; if there is a window, an entrance for fresh air can be made by placing a strip of wood, B, at the bottom of the lower sash, which is thereby raised three or four inches, the air then entering at the middle of the window, as shown in fig. 29. When it is possible, a metal tube of about two inches diameter may be connected with the lamp, as shown in fig. 30, and serves to carry away the products of combustion. Surrounding it is a tube of about six inches diameter, open at the bottom. Both tubes are carried through the roof into the open air, and the top is protected with a cowl. The air between the two tubes becomes heated by the hot gases that are passing up the inner tube, and it consequently rises, and a continual current of air passes up through the space between the two tubes. Another, but less effective, method is to cut a slit in the bottom of the door for the entrance of fresh air and a slit near the top for the exit of foul air, the entrance of light being prevented by a wooden or cardboard casing, as shown in fig. 31. Whenever a room is imperfectly ventilated the door should be left open as much as possible, in order that the air in the room may be completely changed. In such cases it is also advisable that the lamp used for illumination should be placed outside the room.*

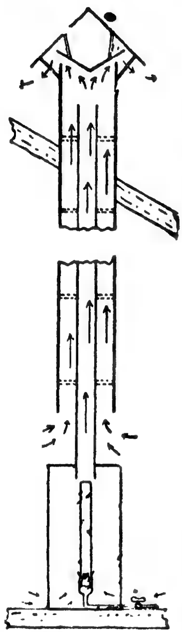

FIG. 30.

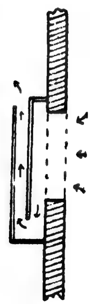

FIG. 31.

Light, as a whole, rapidly affects sensitive plates and other similar photographic preparations, but if the various rays of

* For further details see *Photographic Quarterly*, 1891.

which white light consists are separated, it is found that red, orange and yellow rays affect the eye and enable us to see, but have very little effect on ordinary photographic preparations; whilst the green, blue and violet rays, which act rapidly on our sensitive materials, do not give us (except in the case of the green) much help in the process of seeing. The rays that, separately, produce respectively the sensations of red, orange, yellow, green, blue, and violet, when they act simultaneously produce the sensation of white light. It is clear that we must illuminate our developing room with red, orange, and yellow rays, which are so active optically, but relatively so inactive photographically. The yellow rays act on the more sensitive photographic preparations, and therefore their use is not admissible except in small quantity, and with low intensity; and for general purposes it is desirable to use orange and orange-red rays. In order to obtain this result, ordinary white light is filtered through glass, or a semi-transparent fabric, of a deep orange or orange-red colour. The coloured material absorbs all the rays except the orange, orange-red, and red, but allows these to pass. In no case is light absolutely without action on the sensitive materials, and care should be taken to keep the intensity of the light as low as is consistent with proper visibility, and to avoid unnecessarily exposing the sensitive surfaces to its action. It is important to bear in mind that there is a limit to the absorbing power of the coloured glass or fabric, and one thickness may not be sufficient to give a safe light if the white light behind is intense. In other words, the thickness and depth of colour of the absorbing material, or screen, must be adjusted to the intensity of the light that has to be screened. Remember also that the intensity of the light, and consequently its action on sensitive surfaces, falls off very rapidly as we move away from the source of light.

FIG. 32.

If the work room has a window it may be used as the

source of illumination, the upper half being blocked with some perfectly opaque material, whilst the lower half is glazed with two or three thicknesses of orange glass.* There should also be a red blind inside the window that can be pulled down when the light is too bright. If sunlight falls directly upon the window it is almost impossible to make it really safe. The great disadvantage in the use of daylight is the great variation in its intensity, which makes it extremely difficult to judge properly the opacity of the negatives, etc. It is therefore on

FIG. 33.

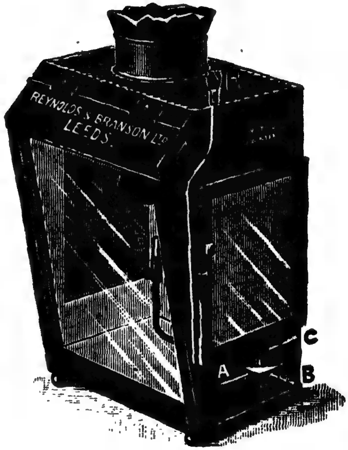

FIG. 34.

the whole better, even when daylight might be used, to work always by artificial light, which can readily be regulated to a practically constant intensity.

The source of illumination may be gas, oil, candles, or electricity. Lamps can be obtained in many different forms. For use with a candle the hock-bottle lamp (fig. 32) is one of the best. For use with petroleum nothing is better than the round wick lamp (fig. 33), with a ruby or orange chimney. Care should

* Ruby glass transmits some violet and ultra-violet rays, an always be combined with orange glass if used as a screen for daylight.

be taken to use petroleum or paraffin of good quality. When gas is employed the Argand burner answers very well, and the same is true of the bye-pass lamp of Reynolds & Branson (fig. 34), which also has a jet outside giving white light when wanted. Several cheaper lamps can be obtained. The best portable lamps for travelling, on the whole, are the folding lamp sold by Lancaster, and the newer self-adjusting candle-lamp with a round chimney.

The intensity of the light should be such that it is possible to read a newspaper at a distance of not less than a foot from the front of the lamp, and even more light may be used with advantage, provided that it is of the right kind. In order to test the safety of the light put a plate in a dark slide, and then, by partially drawing the shutter, expose one half of the plate to the light for one minute at a distance of a foot from the lamp, the other half being protected. Then, as far from the lamp as possible, put the plate in the developer and develop for three minutes. If the unexposed half remains clear whilst the exposed half is fogged, the light is not safe, and either a smaller flame or a deeper screen must be used, or developing, etc., must be done at a greater distance from the lamp. It is quite possible to obtain clear negatives even with a light that gives a slight fog under the conditions stated, but in this case great care has to be taken to keep the plate as far away from the light as is practicable, and to expose it to the light for as short a time as possible when examining it during the process of development.

Much might be said about the relative merits of transparent and semi-opaque materials for the construction of developing lamps. Judging of the opacity of negatives, etc., is much more easily done when the flame of the lamp is visible through a transparent screen, but, on the other hand, it is much less fatiguing to the eye if the light is diffused by a screen of a semi-transparent substance. The best plan is to have a semi-transparent screen in the front of the lamp, and a transparent screen at the side, the lamp being arranged so that it can be turned partly round when a negative is to be examined. Another plan is to have a piece of ground glass in front of the lamp, fixed in such a way that it can be lifted or turned aside when necessary.

Apparatus, a list of which is given at the end of this chapter, should be kept each in its own place, and should always be carefully cleaned before being put away. Dirt, as a rule, is easy to remove whilst moist, but much more difficult to remove if it is once allowed to dry. If water, with the help of a brush or sponge, fails to remove the impurity, try commercial hydrochloric acid diluted with water; or, if the impurity is of a greasy nature, a solution of caustic soda, or of washing soda, may be used. The action of the soda in removing grease is greatly assisted by the addition of methylated alcohol. Take care, in all cases, that the towels or dusters used for drying the apparatus are clean.

Chemicals * when solid should be kept in bottles or jars with well-fitting corks, stoppers, or lids. A dry and cool place, out of the way of the products of combustion, etc., is indispensable. Solutions should be kept in narrow-mouthed bottles with well-fitting corks or stoppers. Indiarubber corks are best for solutions of potash and soda, whether caustic or carbonate, but in other cases glass stoppers are preferable. Green glass bottles of the pattern of what is known as a Winchester quart are cheap and serviceable. The dark blue bottles of the same pattern should be avoided, as the glass is much more easily attacked by the solutions. These bottles can be obtained in the following sizes :—80 to 100 oz. (Winchester quart), 40 oz., 20 oz., 10 oz.

Bottles containing solids or solutions should always be carefully labelled. Sand blast labels are permanent, and not very costly. Failing these, gummed paper labels with the name, etc., printed or written (Chinese ink is best), may be used. They should be sized with one or two coatings of a solution of gelatine, and varnished with copal varnish, slightly thinned with turpentine if necessary.

Solutions * should always be made up so that they contain a definite quantity of the active substance (by weight if solid, by measure if liquid) in 10 or 100 parts by measure of the solution —*i.e.*, so many grains in 10 or 100 grains by measure, or so many ounces in 10 or 100 ounces by measure. It is a good plan to ascertain once for all the height to which a bottle must be filled in order that it may contain 10 oz., 20 oz., or some

* See Appendix.

other definite quantity of liquid. This is done by carefully pouring that quantity of water into the dry bottle from a measure, and marking the height at which it stands by means of a diamond or a file.

Solid substances to be dissolved should always be finely powdered, and should be well agitated with the liquid until solution is complete. Hot water should be used when possible, but care must be taken that the quantity used is less than the intended volume of the solution, and the liquid must be allowed to cool before being finally made up to a definite volume. Some substances, such as iron sulphate, must be dissolved in cold water, and the solution must be protected from the air as much as possible.

There is a limit to the quantity of a solid that a liquid can take up at a particular temperature, and this quantity is greater the higher the temperature, and *vice versâ*. Solutions should not be made so strong that they are liable to deposit part of their constituents if the temperature falls to, say 50° F. (10° C.).

When a liquid requires filtering, a grey or white filter paper, of suitable size, is folded in half, and then in a quadrant; and when one side of the quadrant is opened we have a hollow cone of 60°, which fits into an ordinary glass funnel. If the funnel is plain the paper should be moistened with water, and carefully fitted to the funnel by squeezing the air out from between the glass and the paper by means of the fingers. A ribbed funnel filters more quickly, but the paper is more liable to break, especially when large quantities of liquid are used. The funnel may be supported on a funnel-stand, or may rest directly in the neck of the bottle. In the latter case there must be sufficient space between the neck of the bottle and the stem of the funnel to allow the air to escape as the liquid runs in.

The following list of apparatus contains only the indispensable articles; their sizes will, of course, depend on the size of plates used :—

Orange or ruby lamp.
Three ebonite, xylonite, or papier maché dishes.
Measure (1 oz. or 2 drs.), graduated in minims or fluid grains.
Larger graduated measure (for developing).
Graduated measure (10 oz., for mixing solutions).
Two or three porcelain dishes (deep) for prints.

Rack and trough for washing plates.
Large dish or tub for washing prints.
Apothecaries' scales (glass pans) and weights.
Flat camel's hair brush.
Four printing frames.

The following is a list of the chemicals required, and the quantities that will serve to start with, if half-plates are to be used :—

Alcohol	1 pint
Alum	½ lb.
Ammonia solution ·880	1 oz.
Ammonium bromide	1 „
Ammonium sulphocyanide	2 „
Borax	2 „
Ferric chloride	1 „
Ferrous sulphate	4 „
Gold chloride	15 gr.
Hydrochloric acid (coml.)	½ lb.
Hydroquinone (quinol.)	1 oz.
Hypo. (sodium thiosulphate)	1 lb.
Mercuric chloride	1 oz.
Metol	1 „
Potassium bromide	1 oz.
„ ferricyanide	1 „
„ metabisulphite	1 „
„ oxalate	½ lb
Pyrogallic acid (pyrogallol)	1 oz.
Sodium acetate	2 „
„ carbonate (anhyd.)	4 „
or	
Soda crystals	½ lb
Sodium hydroxide (caustic soda)	1 oz.
„ sulphite	4 „
Sulphuric acid	2 „

CHAPTER VII.

DEVELOPMENT OF NEGATIVES.

A PLATE that has been properly exposed does not differ in appearance from one that has not been exposed at all; the action of the light produces no visible effect, and the image is said to be *latent*. The effect of the light, though invisible, has been great, for if the plate is treated with a suitable chemical solution called a *developer*, those parts of the silver bromide which have been acted on by light are reduced to black opaque metallic silver, whilst those parts which the light has not affected remain unchanged. The function of the developer is to convert into a visible image of silver the invisible image formed by the action of light on the silver bromide, and the process is called *development*.

Developing agents may be divided into two groups—namely, *actual developers*, like ferrous oxalate, and *potential developers*,

like pyro., or quinol, that have no developing power of themselves, but become developers when mixed with an alkali. Eikonogen belongs really to the first class, but its developing power is greatly increased by the addition of an alkali. For negatives, pyro., quinol, metol, and ortol are chiefly used.

Pyro. (pyrogallol, or pyrogallic acid) is a white, light, feathery solid, very soluble in water or in alcohol. It is very poisonous. The solid must be kept in well-corked bottles out of contact with any ammonia fumes; the solution will only keep if the air is completely excluded or the liquid has been acidified.

Hydroquinone (Quinol) is a white crystalline solid, not very soluble in water, but somewhat more soluble in alcohol. It is less liable to alter than pyro., but must be kept in well-closed bottles.

Metol is also a white crystalline solid, and is fairly easily soluble in water. It must be kept in well-closed bottles, though it is not very rapidly affected by air.

The *alkali* used with pyro. may be ammonia, ammonium carbonate, sodium carbonate, or potassium carbonate; caustic potash and caustic soda cannot be used with satisfactory results. In the case of hydroquinone, on the other hand, the alkalies used are caustic soda and caustic potash, sodium carbonate or potassium carbonate; ammonia or ammonium carbonate does not give good results.

A *soluble bromide* must be used with the caustic alkalies, and in some cases with the carbonates likewise. Potassium bromide must be used in all cases except when the alkali is ammonia, and then ammonium bromide may be employed. Both these salts are easily soluble in water.

Ammonia, as met with in commerce, is a solution of ammonia gas in water, and is usually supposed to have a specific gravity of 880 ("ammonia 880"), water being 1000; the lighter the ammonia solution the greater the proportion of gas that it contains. If kept in a concentrated form the solution gradually becomes weaker and weaker, owing to the escape of some of the gas every time the bottle is opened. The strong solution should therefore be diluted up to exactly ten times its volume, by addition of water, as soon as it is purchased, and the bulk should be kept in a well-stoppered stock bottle, from which a smaller bottle is filled for use.

Caustic potash and caustic soda vary greatly in purity, and should be bought in sticks, which should appear quite dry and smooth on the surface. They quickly absorb moisture and carbon dioxide from the air, and must be kept in very well-corked bottles. They rapidly corrode the skin, clothes, wood, etc., and dissolve very readily in water.

Potassium carbonate also readily absorbs water from the atmosphere, and not only must it be kept in well-closed bottles but it must be heated in an oven in order to dry it before it is weighed out.

Sodium carbonate occurs in three forms: (1) anhydrous, consisting entirely of the salt, and somewhat liable to absorb water when exposed to the atmosphere, (2) monohydrated sodium carbonate, consisting of 85·5 per cent. of the salt and 14·5 per cent. of water, undergoes no change when exposed to air, (3) crystallised hydrated sodium carbonate ("soda crystals"), consisting of only 37·0 per cent. of the salt and 63·0 per cent. of water; when exposed to the air the crystals lose water, crumble to powder, and change into the second form. Since the proportion of the active constituent in these three forms is so different, it is necessary to know which form you are using, and which form is specified in any formula. All three forms are soluble in water. The following table shows the quantities of the three forms that are equivalent to one another:—

Anhydrous sodium carbonate		Monohydrated sodium carbonate		"Soda crystals"
1·00	=	1·17	=	2·70
0·85	=	1·00	=	2·31
0·37	=	0·43	=	1·00

Potassium bicarbonate and sodium bicarbonate (also called bicarbonate of potash and bicarbonate of soda) are different from the carbonates in their properties, and are not suitable for use in the developers.

The object of development is to leave unchanged those parts of the silver bromide that have not been altered by light, but to reduce the rest to metallic silver in proportion to the amount of light action, so that there is the greatest deposit of silver where the image was brightest, and the least deposit where the image was darkest. It follows that the result will be the reverse of the original as regards light and shade—

black where the image was bright and *vice versâ*—and a consideration of the mode of formation of an image by a lens will show that the image is also reversed as regards right and left. An image of this kind is termed a *negative image*, or briefly *a negative*. The production of a negative is simply a means to an end, the end being the production of a *positive image* or *positive*, which is a true representation of the original object as regards light, shade, and position.

How far the positive is an accurate representation of the original with respect to the relative brightness of the lights and shadows depends upon the character of the negative, and this, with any particular kind of plate, depends on the length of the exposure and the method of development. Both these factors exert considerable influence on the printing qualities of the negative. As previously stated, short exposures tend to give contrasts greater than those of the original, whilst long exposures give reduced contrasts; very long exposures, in fact give negatives almost equally black all over.

There are four active constituents of the developer :—

1. *The reducer*—*i.e.*, the pyro., hydroquinone, or metol.
2. *The accelerator*—*i.e.*, the alkali, which sets the reducer working.
3. *The restrainer*—*i.e.*, the bromide.
4. *The solvent and diluent*—*i.e.*, the water.

The absolute quantities and relative proportions of these ingredients that will give the best results, assuming that the exposure has been correct, depend on the nature of the plate; the differences being most notable in the case of the quantity of alkali that can be used without producing general fog—*i.e.*, a deposit of silver all over the plate, even on those parts that have not been affected by light.

It has already been stated, however, that a solution of pyro. alters rapidly unless air is completely excluded, a result due to the fact that the solution absorbs ammonia vapour from the air and becomes very slightly alkaline, the pyro. then absorbing oxygen from the air. If the pyro. solution is kept acid it does not absorb oxygen. It is found that if the pyro. solution contains an alkali sulphite, and *has an acid reaction*, it can be kept for a considerable length of time, and

retains its activity. The sulphite has another very beneficial effect; even after addition of the alkali the solution remains clear, acquires only a yellow or brownish yellow colour, and does not stain the gelatine. If the sulphite is not present the pyro. solution very rapidly absorbs oxygen from the air after the alkali has been added, and during the process of development it acquires a deep brown colour, making it difficult to watch the operation, and staining the film so much that the use of a clearing solution becomes necessary at a subsequent stage of the manipulations. The best form in which to use the sulphite in the pyro., quinol, or metol solution is as potassium metabisulphite, or sodium metabisulphite; in the alkali solution sodium sulphite is used.

The influence of the composition of the developer on the character of the negative has been made the subject of a large number of experiments. Broadly speaking, it may be said that the chief effects of such modifications as are usually made are: (1) to reduce or increase the amount of general chemical fog, or, in other words, the reduction, by the action of the developer alone, of silver bromide that has not been acted on by light; (2) to retard the rate of development, so that it can be more easily watched and more easily stopped at the right time; (3) to increase the rate of development.

The results in the case of the pyro. developer may be summed up in the following way, it being understood that in every case the *printing quality* of the negative is referred to:—

An increased proportion of reducer tends to increase the contrasts, but nothing is gained by increasing the quantity of pyro. beyond 8 grs. per fluid oz. (20 pts. per 1000).

A reduction in the proportion of the reducer tends to lessen the contrasts, and at the same time makes development slower.

An increased proportion of alkali makes development more rapid, increases the tendency to fog, and reduces the contrasts.

A reduced proportion of alkali makes development slower, reduces the tendency to fog, and increases the contrasts.

An increase or decrease in the proportion of bromide has very little direct influence on the contrasts. The function of the bromide is to prevent the production of chemical fog by the action of the alkali, and in this way it indirectly prevents reduction of the contrasts by allowing development to be carried

on for a longer time. The proportion of bromide required to prevent chemical fog varies with the nature of the plate and with the proportions of reducer and alkali that are used at the same time.

In practice, these facts are utilised in the following kind of way:—If the contrasts in the subject are weak, or if over-exposure is feared, develop with a larger quantity of pyro. (say twice the usual amount), and keep the proportion of alkali low, at any rate, in the early stages of development. If, on the other hand, the contrasts in the subject are very strong (*e.g.*, a waterfall, with dark rocks in shadow), or if under-exposure is feared, start with the full proportion of alkali, and with a low proportion of reducer, such as one-half, one-quarter, or even one-eighth of the usual amount, adding water to make up the volume of the developer, and as soon as the necessary amount of detail is out in the shadows, increase the reducer to the usual amount if necessary, in order to obtain sufficient density or opacity of the image.

Development with pyro. will be described first, since this is the method most largely used for the production of negatives.

Pyro.-soda.—This developer has the advantages (1) that it evolves no gases, and can therefore be used in comfort by those who find ammonia irritating or injurious, and (2) that it rarely produces green fog, and, if a proper proportion of bromide is used, is less liable to produce general fog. Its disadvantages are (1) a somewhat greater tendency to produce frilling, in consequence of the necessity for using comparatively strong solutions of alkali, and (2) that it does not readily admit of any considerable modifications in the composition of the developer.

This is the developer recommended by the makers for use with all Ilford plates and films, but excellent results can also be obtained with other developers. It is especially convenient when large numbers of plates have to be developed, their exposures having been fairly accurately timed.

PYRO. STOCK SOLUTION.

Pyro.	1 oz.	25 parts.
Potassium meta-bisulphite	70 grs.*	4 ,,
Water, *up to*	6 ozs.	150 ,,

* When hard water alone is available for making up the solution, the quantity of meta-bisulphite should be increased to 90 grains.

Dissolve the meta-bisulphite in water before adding it to the pyro. This stock solution remains good for a considerable time, even in a partially filled bottle.

No. 1.—Pyro. Solution.

Pyro. stock solution.	from 1 to 2 ozs.	1 to 2 parts.
Water	up to 20 „	20 „

The amount of pyro. to be used depends on the quality of negative required; the more pyro the stronger the contrasts (see p. 59). This solution may be kept for a short time only.

No. 2.—Soda Solution.

Soda crystals*	2 ozs.	44 parts.
Sodium sulphite	2 „	44 „
Potassium bromide†	20 grs.	1 „
Water, *up to*	20 ozs.	440 „

Dissolve the salts in about 15 ozs. of hot water, and when cold make up to 20 ozs. by addition of more water. Filter, if necessary. The solution may be kept for a long time, preferably in a hard green glass bottle (see p. 53), or, at any rate, in a bottle not made of lead glass. It should be kept well closed with an india-rubber stopper or a good ordinary cork; if a glass stopper is used, the stopper and the inside of the neck should first be wiped perfectly dry, and then be well rubbed with solid paraffin, in order to prevent the stopper from sticking.

Mix Nos. 1 and 2 in equal quantities immediately before use. As a rule, the development of a quarter-plate requires 1 to 1½ fluid oz. of developer, a half-plate from 2 to 3 ozs., and a whole-plate from 3 to 4 ozs., according to the size and character of the dish that is used. In all cases, more than sufficient developing solution to cover the plate should be used, in order to prevent the formation of air bubbles on the surface of the plate. If films lie quite flat they require the same quantity of developer as plates, but if they curl at the edges they may require more.

Let us suppose that a half-plate ‡ is to be developed. Mix 1½ oz. of pyro. solution with 1½ oz. of soda solution. Take the plate from the slide, brush it rapidly and lightly with a *perfectly clean* flat camel's-hair brush, and place it film upwards in a

* See p. 57. † Ammonium bromide must *not* be used.

‡ The development of films is carried out in precisely the same way.

clean ebonite or papier-maché dish. Now pour the mixed developer over the plate, taking care that the latter is completely covered. If any air bubbles form they must be removed by means of the finger. In order to ensure the developer sweeping all over the plate, begin to pour from the mixing glass at one corner of the dish, and as you pour, move the glass rapidly but steadily along the edge of the dish to the other corner. Perform these operations at such a distance from the orange lamp that you can just see distinctly what you are doing. Now wait—rocking the dish occasionally, and watching for the appearance of the image. If the plate has been properly exposed the image will not appear until after about a minute (*in the dark room a minute seems a very long time, and until you have had experience you will be very liable to under-estimate it*); the high lights will then begin to appear, followed gradually and regularly by the half-tones, and finally by the shadows. The way in which an image appears at the beginning indicates whether the plate has been correctly or incorrectly exposed. If the image comes up gradually and slowly, in the manner indicated, allow development to continue, with occasional rocking of the dish, until the high lights and the brighter half-tones are distinctly visible at the back of the plate. Now lift the plate from the dish, and, holding it between the eye and the lamp, examine carefully the apparent opacity of the image. If the high lights are quite opaque, and the detail in the deepest shadows is distinctly, though faintly, visible, development may be regarded as finished. The developer is poured off, and the plate washed for a short time in the same dish, or in another, in several changes of water, or, better, in a gentle stream of running water; it is then immersed if necessary in alum solution (p. 67) with occasional rocking, again washed very thoroughly, and fixed.

If the image takes considerably longer than a minute before it begins to appear, and then the high lights come up rapidly, together with the brighter half-tones, but the darker half-tones and the shadows fail to appear, the plate is under-exposed. Under-exposure is very difficult to remedy.* Quickly pour the developer back into the mixing glass, and flood the

* The metol developer is very valuable in cases of under exposure. See p. 72.

plate with water. Then dilute the developer with an equal volume of water, or even more in extreme cases, pour off the plain water that is in the dish, and again cover the plate with the diluted developer, and allow development to continue until all the detail is out in the shadows. or the high lights have become opaque. The longer development is continued beyond a certain point, the stronger will be the contrasts, but it is of little use to carry on development beyond the point at which the highest lights have become practically opaque.

If the image appears much before the expiration of a minute and comes up rapidly, the plate is over-exposed. Pour off the developer at once, and pour over the plate some pyro. solution alone, and allow development to continue. As soon as development slackens, or if the image seems likely to be too strong in contrast, pour the pyro. solution out of the dish into all or part of the original developer, and pour the mixture back over the plate. If over-exposure is suspected at the outset, do not add the full quantity of alkali at the beginning of development.

If it is found that there is a tendency to the production of general fog, which cannot be traced to over-exposure, accidental exposure, or an unsafe developing light, increase the proportion of potassium bromide to 1 gr., or, if necessary, 2 grs. per oz. It is important to remember, however, that the effect of bromide is much greater with soda as the alkali than it is with ammonia, and too large a proportion of bromide will make development very slow.

To judge when to stop development, or, in other words, when the negative is sufficiently opaque, is always difficult. Use always the same lamp, and keep the flame at the same height, and hold the negatives at the same distance from the lamp. It is easier to judge opacity when the flame is screened by a transparent material than when the flame itself is not visible. With the Ilford plates the appearance of the image at the back should be observed, as well as the apparent opacity of the image by transmitted light.

It may be said that, as a rule, the maximum useful effect has been obtained when every part of the image has at least become slightly grey, but the edges of the plate, which were protected by the rebate of the dark slide, remain white. As

soon as the edges begin to go grey, it is a sign that general chemical fog is setting in, and development should not, as a rule, be carried beyond this point, although in a few cases a certain amount of fog may help the printing quality of the negative by reducing the contrasts.

Pyro.-ammonia.—This developer, which was for a long time almost exclusively used with gelatino-bromide plates, has the advantages (1) that the constituents can be kept in concentrated solutions and diluted as required, (2) and that great modifications can easily be made in the composition of the developer. Its disadvantages are (1) that, unless carefully used, it may produce both general fog and green fog, and (2) some people find the fumes of the ammonia very irritating to the nose and air passages.

Three solutions are required :—

No. 1.—Developer (Pyro.).

Pyro.	1 oz.	1 part.
Potassium metabisulphite	1 ,,	1 ,,
Water, *up to*	10 ozs.	10 parts.

No. 2.—Accelerator (Ammonia).

Ammonia ·880	1 oz.	1 part.
Water, *up to*	10 ozs.	10 parts.

No. 3.—Restrainer (Bromide).

Ammonium bromide	1 oz.	1 part.
Water, *up to*	10 ozs.	10 parts.

Notice that these are so-called 10 per cent. solutions—*i.e.*, contain 1 part of the active ingredient in every 10 parts of the solution. A normal developer would contain in each fluid ounce 20 fluid grains of pyro. solution, 40 of bromide solution, and 60* of ammonia solution. If minims are used instead of fluid grains (and the ordinary measures are usually graduated in minims), the same relative proportions will be maintained,

* The metabisulphite being an acid salt, neutralises part of the ammonia, and hence it is necessary to use a slightly larger quantity of the alkali than with a plain solution of pyro. The quantity of metabisulphite specified—namely, 2 grs. per oz. of mixed developer—will neutralise about 0·9 gr. of ammonia ·880, and will exert the same influence in keeping the developer clear, and preventing stains, as about 5 grs. of ordinary sodium sulphite.

but the mixed developer will be a little more dilute. There will, however, be no noteworthy difference in its effect.

It should be regarded as a fundamental principle that development should be kept well under the control of the photographer, and in order to ensure this the total quantity of alkali and bromide specified should not be added at the beginning.

Let us assume that a half-plate is to be developed. Measure off 60 fluid grs. (or minims) of the pyro. solution and dilute to 3 ozs. by addition of water. In another measure mix 180 fluid grs. (or minims) of ammonia solution with 120 of bromide solution. The plate is lightly brushed with a *perfectly clean and dry* flat camel's-hair brush, and placed film upwards in a clean developing dish. Now add not more than half the mixed bromide and ammonia solution to the diluted pyro. solution, and pour the mixture over the plate, with all the precautions described on p. 62.

After a certain time, depending on the nature of the plate, the high lights of the image will begin to appear, followed gradually but not very quickly by the half-tones. This should be carefully watched, for the way in which the image develops in the early stages of the process affords valuable indications as to whether the exposure has been correct. If the image comes up gradually and slowly, and the half-tones do not follow very rapidly after the high lights, it is probable that the exposure was right. Pour the developer back into the mixing glass,* add the remainder of the ammonia and bromide mixture, and again pour the developer over the plate with the same care as at first. Allow development to continue, with occasional rocking of the dish, until the image as a whole has acquired sufficient opacity. The very highest lights should be opaque, and the details in the deepest shadows should be distinctly though faintly visible (see p. 63). The plate is removed from the developer and washed with water, and is then ready for fixing. If any signs of frilling are observed, the plate, after being

* N.B.—Whenever any ingredient is to be added to the developer the latter must always be poured off the plate into the mixing glass. An attempt to make any addition to the developer whilst it is in the dish almost always leads to irregular development, with consequent patches of uneven opacity.

washed, should be immersed for a few minutes in alum solution (p. 67), and again thoroughly washed before fixing. With the plates manufactured at the present time, however, frilling with the ammonia-pyro. developer is rare.

If the image comes up rapidly and the half-tones appear very soon after the high lights, over-exposure is indicated. In this case allow the action to proceed without adding any more of the ammonia mixture, and only add small quantities of the latter from time to time when the development seems to have stopped. By thus keeping the development in check you will probably secure a satisfactory negative. If the half tones and high lights appear almost simultaneously, indicating very great over-exposure, quickly pour the developer back into the glass, and rinse the plate thoroughly with water. To the liquid in the glass add a further quantity of 40 fluid grs. (or minims) of pyro. solution, pour it back over the plate, and allow development to proceed. In some cases it may be advisable to pour over the plate a solution of pyro. alone, adding some ammonia and bromide mixture in small quantities from time to time. If you have any reason (from the behaviour of the previous plates, for instance) to suspect considerable over-exposure, start with only one-third of the ammonia mixture, and be very careful to add the remainder only in small quantities at a time.

If moderate under-exposure is indicated (p. 62), at once pour back the developer into the mixing glass and rinse the plate with water. Add to the developer the whole of the remainder of the ammonia and bromide, and pour it back over the plate. If the half-tones and shadows still fail to appear, dilute the developer with half its volume or an equal volume of water, add a small quantity of ammonia solution without any bromide, and pour over the plate. If the plate seems to have been much under-exposed, dilute the developer largely with water, and add a little ammonia (without bromide) from time to time. Development should, if possible, be continued until at least the chief details of the shadows appear, but it is of very little use to carry on development beyond the point at which the high lights have become opaque. Of course, after the developer has been diluted, development will proceed more slowly, and it may be necessary to add a little more ammonia solution from time to time.

When working with very rapid plates, and sometimes with

plates of ordinary rapidity, there is a tendency to general fog which cannot be traced to any accidental exposure to light. In such cases the proportion of bromide should be increased, and the bromide solution and the ammonia solution may be mixed in equal volumes. If necessary, still more bromide should be used.

Frilling.—Sometimes, though with Ilford plates not often, the film begins to "frill," that is to say, it detaches itself from the glass and puckers up round the edges of the plate. The puckering will gradually spread toward the middle of the plate, and the film may become completely detached from the glass. Even with slight frilling the film is very liable to be torn, and when the plate dries there are marks all round the edges, which may spoil the print. The chief causes of frilling, apart from faults in the manufacture, are: (1) use of too large a proportion of alkali; (2) too high a temperature during development; (3) changes of temperature, caused by putting the plate out of a cold liquid into a warm one, or *vice versâ*. Frilling is most frequently met with in hot weather and in hot climates. When a plate shows signs of frilling it should be carefully washed for a short time, and placed in a solution of alum, which toughens the film and stops the mischief.

Alum	$1\frac{1}{2}$ ozs. .	7·5 parts.
Water, *up to* . . .	20 „ .	100·0 „

After remaining in this solution for five minutes it is again carefully *but thoroughly* washed, and may be fixed, or if necessary may be put back into the developer.

A solution of chrome alum is still more effective than ordinary alum.

Chrome alum . . .	$\frac{1}{2}$ oz. .	2·5 parts.
Water	20 „ .	100·0 „

Whenever alum is used the plates must be thoroughly washed after removal from the alum-bath and immersion in the fixing-bath, or *vice versâ*, because if alum and hypo. come together chemical decomposition takes place, with precipitation of sulphur and alumina. This danger is avoided by the use of formalin instead of alum.

Formalin is a 40 per cent. solution of formaldehyde (which is a gas at ordinary temperature) in water; it has the property of toughening gelatine and making it insoluble, even in very

hot water. For use, formalin is diluted with from 10 to 20 times its bulk of water, and the plate or film is immersed in it for from five to ten minutes, and is afterwards washed. The gas that escapes in small quantity from the formalin solution is somewhat irritating to the eyes and nose, and it is not advisable to dip the fingers in the solution more than is really necessary; but the action of the formalin on gelatine makes it a very valuable reagent to the photographer.

Although alum or formalin stops the frilling, it does not remove it. After the plate has been fixed and well washed, place it in a dish and cover it with methylated spirit. Rock the dish carefully for several minutes, remove the plate, allow it to drain, and carefully press the film into its proper place with the fingers. If the film has not contracted sufficiently, place it in a fresh quantity of strong methylated alcohol; if it has contracted too much, add a little water to the first quantity of alcohol and put the plate back into it for a few minutes, rocking the dish the whole time. The *rationale* of this process is that the film frills because it absorbs too much water, and expands; the methylated alcohol removes this excess of water.

Fixing the Image.—The image in metallic silver, produced by the action of the developer following upon the action of light, is mixed with the unaltered silver bromide, and the next process is the removal of the latter. This is based upon the fact that sodium thiosulphate, or hyposulphite, commonly known as "hypo.," acts upon the insoluble silver bromide and converts it into silver sodium thiosulphate, a compound that dissolves easily in water. The developed negative, after being washed, is placed in a *fixing solution* of the following composition.

Hypo. . . .	16 ozs. .	40 parts.
Water, *up to* .	40 ,, .	100 ,,

Here it is allowed to remain, with occasional rocking, until the whole of the unaltered silver bromide is dissolved away. This is best ascertained by examining the back of the plate by holding it in such a position that the light of the lamp is reflected from it, preferably with something black (*e.g.*, the developing dish) behind it. If the bromide has disappeared from the back of the film it is fair to assume that it has all been dissolved; but it is advisable to leave the negatives in the fixing

solution for a minute or two after they seem to be fixed, in order to ensure complete removal of the silver bromide.

To ensure perfect fixing it is a good plan to have two dishes of hypo. solution, the plates being put into the second dish for a few minutes after they seem to be completely fixed in the first dish. After several plates have been fixed and the action of the hypo. in the first dish begins to be slow, the hypo. in the second dish may be taken for the first fixing solution, while a fresh quantity is poured out for the second treatment.

Hypo. solution of half the strength of that given (*i.e.*, 16 ozs. in 80 ozs., or 20 parts in 100) may be used, but of course acts less rapidly.

After fixing, the negative is well washed in not fewer than six changes of water, the plate remaining in each quantity of water for not less than five minutes, with frequent rocking, and each quantity of water being well drained off before the next is added. A gentle stream of running water is more effective, and, whilst this may be applied in a dish, it is best to support the negatives in a proper washing-rack, which is placed in a small tub or tank, or even in a bucket, through which the water runs. Care must be taken that the water in the vessel is thoroughly changed, and that the fresh water does not merely run over the top; the fresh water must come in at the bottom, and the waste water escape at the top, or *vice versâ*. It is thorough washing rather than long washing that is required, and washing for an hour or, at most, two hours, in water that is continually changing, is quite sufficient. A somewhat longer time will be required if the water is only changed occasionally, and in this case it is almost imperative that the negatives should be supported in a rack in a vertical position.

After the negative has been fixed and washed it must be dried, and this must be done at the ordinary temperature, or a very little above it, for if the wet gelatine is made hot it will melt. If, however, the plates have been thoroughly treated with formalin they may be dried with the aid of heat, and this is convenient if prints are wanted in a hurry. Alum is less effective than formalin in preventing gelatine from melting. It is not advisable in any circumstances to apply heat to expedite the drying of films. The negatives must be dried as quickly as possible, and under such conditions that no dust can

fall on the film. They may be allowed to remain in the washing-rack after the latter has been removed from the trough, especially if the rack is put in a moderately warm place; but this plan is not to be recommended, for they dry slowly, and unless the plates have been thoroughly washed those parts that dry last are liable to be reduced in opacity. An excellent plan is to drive some long nails into a wall, or a board supported against a wall, so that the nails project from 1 to 2 inches, according to the size of the plate, which also regulates the distance from one nail to another. The negatives are then supported, film downwards, in the manner shown in fig. 35, the lowest corner

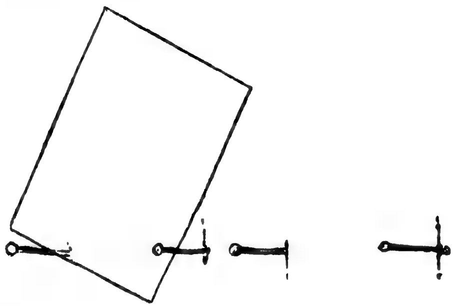

FIG. 35.

resting against the wall. They dry rapidly, and no dust can fall on the film.

Films, if flat and not too large, can be washed in the racks used for plates. Another method, applicable even to large films, is to attach one corner of the film to a spring clip, which is also attached to a cork. The films are supported by the corks in a deep tank or a bucket full of water and through which a gentle stream of water is flowing. When the films are washed the corks are removed and the films are hung by means of the clips, which should have a hook attached for this purpose, on a clean cord stretched across a room as free from dust as possible. In this position they soon dry. Another method of drying is to pin the films by one corner to a clean wooden lath suspended horizontally, or they may be pinned to the lower edge of a clean shelf.

Clearing.—If the plate has been developed with pyro. without sulphite, or with an insufficient quantity, it will be stained yellow or brown, especially if development has been prolonged. If this stain is very distinct after fixing and thorough washing, the plate must be placed for a few minutes, with repeated rocking, in a "clearing solution" composed of—

Alum solution	20 ozs.
Sulphuric acid	120 minims,

and afterwards thoroughly washed.

OTHER DEVELOPERS.

In addition to pyrogallol there are several other developers, of which quinol or hydroquinone, metol, ortol, adurol, and catechol or pyrocatechin are the most important, and they are characterised by the fact that, although with suitable alkalies they are powerful developers of exposed photographic plates, they are acted on by the air much less rapidly than pyrogallol, and consequently the solutions both in stock and during development retain their strength for a much longer time. Further, if mixed with sodium-sulphite they remain almost colourless even after considerable exposure to air. It follows that these developers have practically no tendency to stain either the gelatine film or the fingers, and the same quantity of developer can be used for several plates in succession without any disadvantage, though the action becomes a little slower.

Hydroquinone, or *Quinol*, is not very suitable as a general developer for negatives. It acts slowly and tends to produce density in the high lights rather than to bring out the details in the shadows, with the result that negatives developed with it are liable to be "hard" or to have excessive contrasts. It has, however, very little tendency to produce general fog. For these reasons it is valuable in cases of over-exposure or if negatives with excessive contrasts are desired. A good formula for the purpose is—

HYDROQUINONE SOLUTION.

Hydroquinone	180 grs.	2 parts.
Potassium metabisulphite	180 „	2 „
Water, *up to*	20 ozs.	100 „

SODA SOLUTION.

As for PYRO.-SODA.

Mix the hydroquinone and soda solutions in equal volumes just before use. The temperature of the developer should not be below 55° Fahr., or its action will be very slow. If a quickly acting hydroquinone developer is desired, the following formula may be used :—

REDUCER.			ACCELERATOR.	
Hydroquinone	1 oz. or $2\frac{1}{2}$ parts.		Potassium carbonate	4 oz. or 10 pts.
Sodium sulphite	4 " " 10 "		Potassium bromide	80 grs. or 0·46 pts.
Water . .	40 " " 100 "		Water, *up to* .	40 oz. or 100 pts.

Mix in equal volumes, or 2 parts of reducer, 1 part of accelerator, and 1 part of water, according to the effect desired. It is sometimes advisable to add some old developer (kept in a well-corked bottle filled to the neck) to that freshly prepared before pouring it over the plate.

The effects of altering the composition of the developer are similar to those observed in the case of pyro. Reducing the proportion of quinol, or of the alkali, however, makes development very slow. The negatives have good gradations, but with a tendency to a short range, and consequent exaggeration of the contrasts. The regular action of the developer makes it fairly easy to manage.

Metol differs markedly in its mode of action from hydroquinone, and, indeed, from any of the other developers mentioned. It has the property of bringing out the detail in the half-tones and shadows very rapidly as compared with the production of opacity in the high lights. Consequently a correctly exposed plate in the metol developer behaves very much like an over-exposed plate in the pyro.-soda developer ; the shadow detail appears very soon after the high lights. Afterwards, however, the different parts of the image gain opacity in proportion to the amount of exposure received, provided, of course, that the exposure has been fairly correct, and if the development is allowed to go on until no further action takes place the negative obtained is not appreciably different from that obtained with other developers. If, however, development is interrupted before it has gone as far as it might do, we get a negative with practically the maximum shadow detail that the particular exposure would give, but with less than the maximum possible opacity in the high lights and half tones. In other words, we

have a negative in which excessive contrasts have been prevented. For these reasons metol is especially valuable in cases of minimum or under-exposure, or where the subject has excessive contrasts of light and dark. For the same reasons it is altogether unsuitable for cases of over-exposure or subjects with weak contrasts.

It should be mentioned that with some people the metol developer produces unpleasant results in the form of an affection of the skin; but such cases are rare, and most people find that they can use metol without any ill effects whatever.

For architectural interiors, hand-camera work, and other cases of minimum exposure, the following formula may be used :—

METOL SOLUTION.

Metol	180 grs.	2 parts.
Potassium metabisulphite .	180 „	2 „
Water *up to*	20 ozs	100 „

SODA SOLUTION.

As for PYRO.-SODA.

Mix the metol and soda solutions in equal volumes. If considerable under-exposure is suspected, or the subject has excessive contrasts, use metol solution 1 part, soda solution 2 parts.

The silver image produced by metol is blue-black in colour, and for a given degree of visible opacity has somewhat less printing opacity than the image produced by pyro.-soda. It follows that development with metol should be carried a little further than with pyro.-soda.

For uncertain exposures, even in the case of architectural interiors and the like, it is not wise to begin development with freshly mixed metol developer; it is better to start with some old developer, kept in a well-corked bottle filled to the neck.

Metol-Hydroquinone.—Whilst neither metol nor hydroquinone can be regarded as the best type of developer for general work, a mixture of the two in suitable proportions makes an excellent all-round developer, and has come into very general use, partly, no doubt, because it has no tendency to stain either the film or the fingers, and the same quantity of developer can be used several times, so that the actual cost of working is not appreciably greater than with pyro.-soda.

If the separate metol and hydroquinone solutions are at hand, the metol-hydroquinone developer can be made by mixing—

Metol solution	2 parts.
Hydroquinone solution	2 „
Soda solution.	4 „

and this answers well for general purposes. It is obvious that by varying the proportions the developer can be made to act more like a simple metol developer—for example, metol 3, quinol 1, soda 4; or more like a quinol developer—for example, metol 1, quinol 3, soda 4.

If a mixed solution is prepared we may use—

METOL-HYDROQUINONE.

Metol	90 grs.	1 part.
Hydroquinone	90 „	1 „
Potassium metabisulphite .	180 „	2 „
Water *to make*	20 ozs.	100 „

For use mix with an equal volume of the soda solution as used for pyro.-soda.

Ortol is a developer which, in its mode of action and general results, very much resembles pyro.-soda, but has the advantage that it does not stain the film or the fingers, and is but slowly acted on by air, so that the same quantity of developer can be used several times in succession. It also has very little tendency to produce fog, and is often a useful developer for plates that are old or for some other reason show a tendency to general fog.

The reduced silver is bluish-black, and, as in the case of metol, development must be carried rather further than with pyro.-soda, in order to obtain the same printing opacity. The author recommends the following formula, which differs from that of the makers of ortol in containing less sulphite:—

ORTOL SOLUTION.

Ortol	130 grs.	15 parts.
Potassium metabisulphite .	65 „	7½ „
Water *up to*	20 ozs. . .	1,000 „

SODA SOLUTION.

The same as for PYRO.-SODA.

Mix the ortol and soda solutions in equal volumes, and if a slow-acting developer is desired, use ortol solution 1 part, soda

solution 1 part, water 1 part. Alterations in the proportions of the constituents and the addition of more bromide have much the same effect as with pyro.-soda.

Adurol is chemically related to quinol, and somewhat resembles it in its mode of action, giving clean negatives free from stain or fog; but it has not the same tendency to produce negatives with exaggerated contrasts, and has the great advantage that it still acts with considerable vigour even at low temperatures, and therefore is especially valuable for winter work. It is used with sodium carbonate as the alkali, and the same formula as for hydroquinone (p. 71) answers well.

Tank or "Stand" Development is a method of working that is very useful in some conditions. The plates, instead of being horizontal in a dish, are placed in a vertical or nearly vertical position in grooves or in movable holders in a tank of porcelain, papier-maché, or ebonite, capable of holding six or twelve plates at once. The developer is used in a highly diluted form, so that its action is very slow, and the progress of development, can readily be watched and checked at any desired point. It is a very useful method when large numbers of plates with uncertain exposures have to be dealt with, or when the plates for any reason show a tendency to general fog. In hot climates or in hot weather in this country the time required for development involves increased risk of frilling, and it is advisable in such circumstances to treat the plates with formalin before development in this manner.

Pyro.-soda can be used as the developer, but is not so suitable as ortol, metol-quinol, metol, or adurol. The developer mixed according to the ordinary formula is diluted with from 10 to 20 times its volume of water, and the plates are immersed in it, taking care that no air-bubbles form on their surfaces. After 10 or 15 minutes they are examined, and the extent to which the image has appeared indicates how long development will take. By diluting the developer to different degrees the time necessary may vary from 1 to 6 or 8 hours, and in the latter case the process may go on whilst other things are being attended to. If desired, development may be started in the tank, and after an indication as to the correctness or otherwise of the exposure has been gained, may be finished in developer of ordinary strength.

CHAPTER VIII.

NEGATIVES AND THEIR DEFECTS.

A PERFECT negative for printing purposes will have the very highest lights of the subject quite opaque, and the very deepest shadows quite transparent; but the rest will show every possible gradation between these extremes, the opacity of the various parts being proportional to the brightness of those parts of the image to which they correspond. In the case of a negative intended for the production of lantern slides or enlargements, it is better, as stated in the preceding chapter, that no part of the film should be quite blank, but all should show some detail, though it will necessarily be faint in the deepest shadows. It is very rarely, however, that a perfect negative is obtained, and in this chapter the chief faults that are likely to be met with will be described, and their causes and remedies explained wherever possible. Some of them arise from faults in the emulsion, others from faults in exposure, development, or the subsequent treatment.

The gradations are good, but the negative is thin—i.e., the deposit is not sufficiently opaque in any part.—The plate was coated with too thin a film of emulsion; or it has been removed from the developer too soon; or perhaps the developer was too cold. It is remedied by the process of *intensification*, which may be effected in several ways; the simplest method, and on the whole the best, consisting of adding to the image of metallic silver a quantity of metallic mercury, proportional at any one place to the quantity of silver already present. This is known as mercurial intensification. The negative must be very thoroughly washed after fixing, and is placed for ten minutes in strong alum solution, and again thoroughly washed. It is then immersed in the following solution:—

Mercuric chloride * . .	½ oz. . .	5 parts.
Hydrochloric acid, pure, conc.	25 minims .	½ part.
Water	10 ozs. . .	100 parts.

If the maximum possible amount of intensification is required, the negative must remain in this solution, with

* Mercuric chloride (corrosive sublimate) is a highly poisonous substance.

occasional rocking of the dish, until the image is quite bleached and converted into a double chloride of silver and mercury. If only slight intensification is needed, immersion must be short. The negative is afterwards *thoroughly* washed and treated in one of the following ways: (*a*) It is treated with the ferrous oxalate developer (this and all the previous operations being conducted in daylight), and allowed to remain until there is no further change. (*b*) Immersed in water containing a small quantity of ammonia until the colour of the image undergoes no further alteration, the white image being changed to deep brown, and the intensification being slightly less the stronger the ammonia used. In either case the plates are again washed and dried.

In the first case the white image is changed into a mixture of silver and mercury. This method is much less liable to produce stains, the intensified image is more permanent, and, if the first intensification is not enough, the process can be repeated until a very feeble image has been built up into one of considerable opacity.

In the second case the white image is turned into a dark brown compound of complex constitution. If patches of brown stain appear, the negative had not been perfectly freed from hypo.

Another very good method of intensification, which deposits on the original image a mixture of silver and mercury, is Monckhoven's cyanide method. Its chief drawback is that it involves the use of the highly poisonous compound potassium cyanide. Two solutions are required.

No. 1.—Mercury Solution.

Mercuric chloride . . .	90 grs. . .	2 parts.*
Potassium bromide . .	90 ,, . .	2 ,,
Water	10 ,, . .	100 ,,
Hydrochloric acid . . .	Few drops .	. Small quantity.

No. 2.—Silver Cyanide Solution.

Silver nitrate. . . .	90 grs. . .	2 parts.
Water	10 ozs. .	. 100 ,,
Potassium cyanide . .	*Quant. suff.*	. *Quant. suff.*

* In the conversion of "grains per ounce" into "parts" the ounce is taken as containing 440 grains, the difference between this and the true number, 437·5, being too small to introduce any appreciable error. In almost all cases small fractions are disregarded, and in some cases the nearest round number is used.

Dissolve the silver nitrate in the proper quantity of water, and to the solution add, drop by drop, with vigorous shaking, a saturated solution of potassium cyanide in water, until the white precipitate that forms at first is nearly *but not quite* redissolved. If the whole of the precipitate should be accidentally dissolved, a strong solution of silver nitrate must be added, drop by drop, until a slight precipitate forms and remains even after vigorous shaking. The liquid is then filtered.

The *thoroughly washed* negative is immersed in the mercury solution until completely or partially bleached, according to the degree of intensification required. It is then well washed and placed in the silver cyanide solution, where it is allowed to remain until the image becomes quite black, when it is again thoroughly washed. Prolonged immersion in the cyanide solution results in a gradual reduction of the image.

In this case also, if the first intensification is not sufficient, the process may be repeated.

Another method which gives a high degree of intensification is Lumiere's modification of the mercuric iodide process. It has the advantage that the presence of minute quantities of hypo. in the film does not interfere with the result, and hence this process is especially suited to rapid work, such as photo-mechanical work with gelatine plates. This intensifier is on the market in a form which only requires to be dissolved in water, but it can be prepared from the following formula :—

Mercuric iodide . . .	45 grs.	1 part.
Sodium sulphite crystals .	2 ozs.	20 parts.
Water *up to*	10 „	100 „

The washed plate immersed in this solution gradually gains in opacity, and when sufficiently intensified it is *thoroughly washed* and afterwards treated with a metol, metol-hydroquinone, or ortol developer, in which it should remain for some time. It is then washed and dried.

The gradations are good, but the negative is too dense or too opaque all over.—Development has been continued too long and the remedy lies in *reduction*, which is best effected by Howard Farmer's method. The negative is thoroughly washed after fixing (if it has been dried it must be soaked in water

for at least half an hour, in order that it may be again thoroughly and uniformly wetted), is placed in a porcelain dish, and covered with fresh fixing solution (hypo.) previously diluted with an equal volume of water. The hypo. is then poured off, mixed with a few drops of potassium ferricyanide* solution—

Potassium ferricyanide . .	1 oz. . .	1 part.
Water *up to*	10 ozs. . .	10 parts.

and returned to the dish. Reduction proceeds somewhat rapidly and must be carefully watched. The negative should be removed whilst still slightly too dense, and rapidly washed. Reduction will proceed a little farther during washing, and the negative should be left in running water for not less than half an hour. If the first quantity of ferricyanide does not cause sufficient reduction, a further quantity must be added, but care should be taken not to make the reducer too powerful. If the reducer is strong it attacks the shadow detail more than the high lights; if weak it acts more evenly.

Local reduction (*i.e.*, reduction of parts of the image) can be effected by lifting the negative out of the hypo., allowing it to drain for a few seconds, and then applying a very weak solution of the ferricyanide to the particular parts by means of a camel's hair brush, and again immersing it in the hypo.

When the ferricyanide and hypo. have been mixed, a chemical reaction takes place between them, and the solution gradually loses its reducing power. Its strength may be restored by the addition of some more ferricyanide, but this process of renewal must not be repeated too often.

An excellent reducer for general purposes is the slightly acid solution of ceric sulphate recommended by Lumiere. It acts regularly, and in general effect is similar to the ferricyanide reducer, but it does not decompose spontaneously, and does not produce yellowish or brownish stains such as are

* Potassium ferricyanide (red prussiate of potash) must not be confounded with potassium ferrocyanide (yellow prussiate of potash), which is useless for this purpose. Potassium ferricyanide, and especially its solutions, should be kept in the dark.

sometimes produced by the ferricyanide. The stock solution contains—

Ceric sulphate	10 parts.
Sulphuric acid	4 „
Water *up to*	100 „

and can be bought ready prepared. For use it is diluted with from twice to ten times its volume of water, according to the rate of action desired. The solution can be used repeatedly until its action becomes too slow for practical purposes. The negatives must be washed before and after reduction, and should not be handled more than is absolutely necessary whilst in the solution.

The negative is flat—i.e., there is not sufficient contrast between the lights and shadows.—This may arise from want of contrast in the subject, from over-exposure, or from the use of a developer too weak in reducer, too strong in alkali, too dilute generally, or too cold. In some cases mercurial intensification will increase the contrasts, but the negative must be clear in the shadows and not too dense to start with. If necessary, the shadows may be cleared by a short immersion in fairly strong Howard Farmer reducer, and the negative can then be intensified with better chance of success.

The negative is hard, the high lights being opaque, the shadows very thin, and the half-tones deficient.—This arises chiefly from under-exposure, but may be partly caused by the use of a developer too strong in reducer or too weak in alkali. Local application of the Howard Farmer reducer may sometimes be resorted to with advantage. The best method, however, of improving negatives of this kind is to reduce them with ammonium persulphate, which has the remarkable and very useful property of greatly reducing the printing opacity of the high lights whilst leaving the shadow detail almost unaltered. The solution should be freshly prepared, and should contain not less than 2 per cent. and not more than 5 per cent. of the per-sulphate (10 grains to 25 grains per ounce). It is sold as a white crystalline solid, and can also be obtained in tabloids. The solution should be slightly acid, and, if necessary, should be mixed with dilute sulphuric acid until it just turns blue ltimus paper red.

The negative, which must be very thoroughly washed, and

if previously dried must be again soaked in water for at least an hour, is immersed in the persulphate solution, preferably in a white dish, and should be carefully watched, the dish being repeatedly rocked. Whilst in the solution the plate or film should not be touched with the fingers, since stains and markings are liable to be produced. When lifting it out for examination, an ebonite or celluloid lifter should be used. If the dish is fitted with a hinged lifter it is still more convenient. When reduction has gone nearly, but not quite, far enough, the plate should be lifted out and at once immersed in a 5 per cent. solution of sodium sulphite, to arrest any further action of the persulphate. It is then well washed and dried.

Fog—i.e., a general deposit of silver all over the plate, including those parts that should not have been acted on by light.—This may arise from bad emulsion; from accidental exposure to light before development; from exposure to active light during development (test the developing lamp in the manner described on p. 52); from the use of a too energetic developer; from over-exposure in the camera, in which case the edges of the plate that are protected by the rebate of the dark slide will remain clear. If the image is fairly vigorous the fog may be removed with the Howard Farmer reducer, and, if necessary, the image can then be intensified.

Partial Fog may arise from exposure of part of the plate to light; or, if it is confined to the edges of the plates, from the action of an impure atmosphere; or possibly, if its extent is sharply defined, from the use of impure paper for packing purposes.

Green Fog, or *Dichroic Fog.*—A deposit which, when looked *at* so that it is seen by reflected light, is bright green; but when looked *through* is pink or reddish. It arises from keeping plates in an impure atmosphere, in which case it occurs chiefly round the edges; from use of too much alkali in the developer; from too prolonged development; from defective manufacture of the plates. If only slight, and on the surface, it can be removed by immersing the washed plate in methylated spirit, and carefully rubbing with a clean finger, or with cotton wool moistened with alcohol. It can be removed by treatment with Howard Farmer's reducing solution largely diluted, but in very bad cases it is best to adopt Abney's method. The negative is

immersed in the following solution until the image is completely bleached :—

Ferric chloride . .	50 grs. . .	3 parts.
Potassium bromide .	30 „ . .	2 „
Water . . .	4 ozs. . .	. 100 „

The negative is then well washed and treated with the ferrous oxalate developer, all the operations being conducted in daylight. It will be found that in the re-developed image the green fog has been replaced by an almost imperceptible grey deposit.

Uneven Density, if in well-defined patches, usually arises from the use of an insufficient quantity of developer to cover the plate properly, or from carelessness in pouring on the developer or keeping the dish level. If the density alters gradually from one edge or corner of the plate to the opposite edge or corner, it is due to a variation in the thickness of the film, arising from uneven coating.

Pinholes, or small transparent spots, usually arise from the presence of dust on the plate during the exposure, but are occasionally due to poor gelatine.

Circular transparent spots, visible as white spots during development, are due to the formation of air-bubbles in the developer, or to the existence of insensitive patches in the emulsion. If in the centre of the spots the glass is not covered with gelatine, they are due to the formation of air-bubbles in the emulsion during coating.

Black spots arise from contact of the prepared plate with dust of a metallic character; from contact with solid particles during development or the subsequent operations; from impurities in the emulsion; from dust falling on the coated plate whilst drying.

Black lines and markings arise from the pressure of some hard substance on the film.

Irregular, wavy, and " oyster-shell " markings are usually due to faults in the coating and drying of the plate.

A white powdery scum is visible on the surface of the plates after drying. It is usually due to the use of very hard water in the washing operations, and consists of salts of calcium. Its formation can be prevented by giving the plate a final washing in one or two changes of rain-water or distilled water. The formation of this deposit is more likely to take place when the

placing it in the holder, with a thin layer of a mixture of a strong solution of dextrin (British gum) with burnt sienna or burnt umber (ground in water) and glycerine. This mixture should contain sufficient dextrin to form an adherent coating, and sufficient glycerine to prevent the coating from becoming very dry and powdery. A still better mixture is dextrin and caramel (burnt sugar), or caramel only, with a little burnt sienna, or burnt umber, as recommended by Debenham. In any case the coating must be done, and the plates allowed to dry, in the dark room. The mixture may be applied with an ordinary flat paint brush, or with a roller squeegee which has been dipped in some of the mixture previously poured into a flat dish. The backing ought to be quite dry before the plates are put into the holders. Great care must be taken that none of the mixture gets on to the film, and before development the backing is carefully removed with a damp sponge.

The backing absorbs the light that passes through the film and prevents its reflection from the back of the plate. It must not only be an effective absorbent of the photographically active rays, but must have as nearly as possible the same refractive index as the glass, in order to avoid reflection.

Plates with films of the ordinary character should always be backed when they are to be used for photographing interiors, or any subject with contrasts so strong that halation is probable.

All the Ilford plates can be bought ready backed.

CHAPTER IX.

PREPARATION OF THE NEGATIVE FOR PRINTING.

VARNISHING.—An unvarnished negative can be printed from for some time without any appreciable injury, provided that it is thoroughly dry, and that the paper is thoroughly dry also. It is always better, however, to varnish negatives that it is intended to keep, or from which many prints have to be made, in order to protect them from injury both during

printing and by drops of liquid or a damp atmosphere. Hard varnish specially made for photographic purposes should alone be used, and it should be perfectly transparent and as colourless as possible.

After the negative is apparently dry, put it into a warm dry place for an hour or two, so that it may be really dry; but do not make it too hot, or there is a danger of the film peeling from the glass. Now hold the negative a short distance in front of the fire, turning it round occasionally until it is slightly warm, great care being taken to warm it slowly and evenly. Hold it face upwards by means of a pneumatic holder, remove any dust by means of a camel's hair brush, and, keeping the plate perfectly level, pour on the film, half-way between the centre and the right hand top corner, a small pool of varnish. Practice will soon teach you how much to use. Now by *gently* inclining the plate make the varnish flow to the nearest corner, then along to the left hand top corner, next to the left hand bottom corner, and finally to the right hand bottom corner. If this is done quickly and steadily, and sufficient varnish has been used, the whole of the film will be covered with varnish. Place the right hand bottom corner (*i.e.*, the last corner) in the neck of a second perfectly dry bottle, and, by tilting the plate, drain off the varnish at this corner, slightly rocking the plate until the varnish no longer drips from it.* Now remove the pneumatic holder and hold the plate (with your thumb and fingers against the edges, and not on the varnished surface) in front of the fire or stove, turning it occasionally, and taking care that the glass is heated evenly and not too rapidly, until the back of the glass is unpleasantly hot when touched with the back of the hand. Put the plate in a rack and allow it to cool.

Perform the operation of coating quickly but steadily, and without any flurry, and take care to use a sufficient quantity of varnish; too much hurry or too little varnish is the cause of most of the failures in varnishing.

Perfect negatives require no treatment beyond varnishing,

* Special varnish cans can be obtained, the upper part of which consists of a funnel into which the varnish from the plate is poured, and from which it filters into the lower part of the vessel and is again ready for use.

but perfect negatives are rare; and, as a rule, much better prints are obtained if a little care is given to a preliminary improvement of the negative. The defects arise partly from the shortcomings inherent in present photographic processes, partly from defective manipulation. A negative is only a means to an end, that end being the positive image or print; and the nearer the negative can be made to approach perfection, the better will be the resulting print. No amount of "doctoring," however, will make up for bad photography; and a practice which is permissible and advantageous when its object is the removal of slight or unavoidable defects becomes in the highest degree reprehensible when pushed to excess.

No retouching, nor any other local treatment of the negative whatever, is permissible when the negative is taken primarily for scientific, historical, or judicial purposes.

When the contrasts are too strong, and all the detail in the shadows is obliterated before the detail in the high lights is printed at all, cover the back of the negative with matt varnish —taking care that none gets on to the film side—or with white tissue paper, which is easily fastened to the glass by means of skim milk or a very thin solution of gelatine or glue. When the varnish or paper is dry, scrape it away from over the high lights, leaving it over those parts that are too transparent. If necessary, these parts may be still further strengthened by working on the varnish or paper with a stump and some powdered charcoal or crayon.

When on the other hand the contrasts are too weak, the high lights and lighter half-tones may be strengthened by working with the stump and charcoal on the matt varnish, or paper, in a similar manner, or by cutting away the varnish or paper from every part except the high lights.

High lights may also be strengthened by the careful application of Indian ink or Prussian blue to the film side of the negative, which for this purpose should have been treated with alum. Apply the colour very cautiously, avoiding sharp edges, and not putting on too much.

Sometimes it is necessary to make a defective sky quite opaque. This is called "blocking out." Place the negative on a sloping retouching desk, and, with a pen having a turned-

up or a round point, work carefully along the sky line with Indian or Chinese ink, making a broad line which touches the horizon of the landscape and accurately follows its contour. It is then easy to join on to this a band of black varnish about a quarter of an inch broad. The rest of the varnish is best put on the back of the negative, taking care that it overlaps the opaque band on the face, but does not encroach on the landscape itself. If feathery foliage comes against the sky, any procedure of this kind cannot be adopted with satisfactory results.

Retouching is the term commonly applied to work done with a pencil on the film of the negative. It can be employed with good effect for strengthening the highest lights and other details in the case of any kind of subject, but it is especially useful for portrait work. The fact that photographic plates are sensitive to certain kinds of rays and not to others makes the plate pick out differences of colour that are not perceptible to the eye. Freckles and other marks that are unnoticeable in the subject become very distinct and prominent in the photographic negative, and small differences of colour, wrinkles, shadows, and excrescences, become greatly exaggerated. The removal of these defects is the legitimate end and aim of retouching; anything beyond is reprehensible, and when an attempt is made to patch up bad lighting and bad photography by excessive retouching the practice cannot be too strongly condemned.

To become a competent retoucher necessitates a considerable amount of study and practice. Read a special treatise on the subject (such as Johnson's) and, if possible, take a few lessons. Some hints on the more important points may be useful, and careful observation and practice must do the rest.

Make a print from the negative as it is, and then carefully examine both print and negative in order to decide what parts require retouching. Err always on the side of doing too little rather than too much.

In order to support the negative in a convenient manner, a retouching desk will be necessary. This usually consists of three boards, or frames, hinged together in such a way that one rests on the table and forms the base of the desk, whilst the middle one can be inclined at any convenient angle, and the

top one can be supported at an angle in the opposite direction and protects the eyes of the retoucher from any light except that which comes up through the negative. If the desk is sufficiently large (and small desks are very inconvenient), some opaque fabric hung from the sides of the top piece cuts off all side light, and affords still greater protection to the eyes. The middle board, or frame, which constitutes the desk proper, has a hole cut in the middle, and over this the part of the negative to be worked upon is put, the negative being kept in position by a movable strip of wood that can be fastened down by pegs. On the base of the desk is placed a sheet of white paper, or a piece of mirror glass, which reflects the light through the negative. The desk should be so placed that it is near a window, with a north light if possible, and that there is no strong light behind the operator. The desk should be at such a height and such an inclination that the operator can sit upright whilst at work.

The surface of the film, even when it has not been varnished, is too hard and smooth to take the pencil marks, and must be prepared by the application of some "retouching medium." Apply a *small* quantity of the medium to those parts of the film that are to be worked upon, by means of a small plug of cotton wool or the end of the little finger, and after you have allowed time for the solvent to evaporate, you will find that the surface is rough and will take the pencil readily.

Use pencils of the best quality—hard or moderately hard, such as H, F, and HB. A B pencil may be used when a considerable amount of filling-in has to be done. Carefully cut each pencil to a long point, and finish the sharpening by carefully rubbing it on sand-paper fastened to a flat piece of wood. Whilst working, keep the point sharp by occasionally rubbing it on the sand-paper, giving it at the same time a rotary motion.

Apply the pencil *very lightly*, making the pressure greater in the middle of the stroke than at the beginning or the end. Make very short strokes, and let their direction follow the lines and curves of the object. If the effect of each single stroke is perceptible, you are applying far too much weight; the irregularities should gradually fill up and disappear as the work progresses. When you are simply removing irregularities

from a surface, it may be necessary to go over the ground two or three times, and care should be taken to keep the strokes all in the same general direction. Use always the hardest pencil with which the work can be done. When, on the other hand, the image has to be strengthened considerably and the work has to be gone over a second time, the second set of lines must cross the first at an angle of 45° or so, and a third set, if necessary, must make an angle with both the first and second set; this is known as "cross hatching." If mistakes are made, the retouching medium, and with it all the retouching, can be removed by means of a clean plug of cotton wool moistened with turpentine.

In landscapes and similar subjects the pencil will be chiefly useful for strengthening the lights and filling up patches of uneven opacity; in portraiture, freckles and similar defects must be filled up, exaggerated wrinkles toned down, and any hardness removed by carefully softening the junction of the lights with the shadows, great care being taken not to alter the contours of the features, nor the form of lights and shadows. Make a careful study of the anatomy of the face, hands, etc., and let your pencil follow the natural curves of the features. Above all, avoid destroying all the character in the subject by such a fatuous proceeding as removing all the wrinkles and reducing the whole of the features to a dull and vapid smoothness.

CHAPTER X.

PRINTING OR POSITIVE PROCESSES.

PRINTING or positive processes, which give pictures corresponding to the original object in light and shade and position, may be divided into two classes—namely, *print-out processes*, in which the action of the light is allowed to continue till all the details of the image are visible, and *development processes*, in which the exposure to light is much shorter, and the image is either faint or is not visible at all, and only appears with its full intensity after treatment with a developer.

The chief print-out processes involve the use of silver compounds, and are known respectively as the *albumenised paper* process; the *gelatino-chloride paper* process, which has largely displaced albumenised paper, over which it has several advantages; and *matt surface silver paper.* The chief development processes are *alpha paper*, *bromide paper*, various *iron processes*, and *platinotype.*

These papers can be obtained either in sheets or cut up to definite sizes. When cutting up the large sheets, a little contrivance is necessary in order to obtain the maximum number of pieces out of a sheet without cutting any to waste. Fig. 36

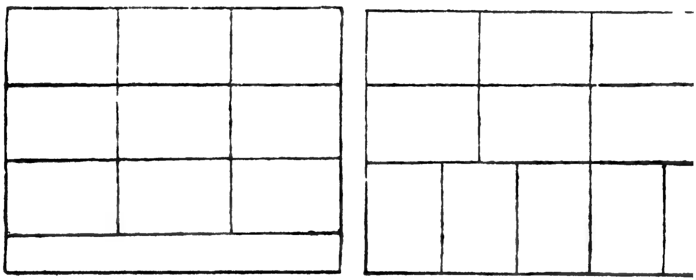

FIG. 36.

shows how, with one method of procedure, only nine pieces, $7\frac{1}{2} \times 5$, can be cut out of an ordinary sheet of albumenised paper, whilst with a slight alteration ten pieces can be obtained —assuming that the paper is good up to the edges. Care must be taken that the fingers are clean and dry, and that the sensitive surface of the paper is handled as little as possible.

The exposure is made by means of a "printing frame"— a strong wooden frame, with a rebate to support the negative, and a hinged back which is provided with springs so that the paper may be pressed into close contact with the negative. With negatives of large size, in order to prevent fracture by the pressure, the frame contains a sheet of plate-glass upon which the negative is placed. In all cases it is desirable to have some sheets of blotting-paper or felt, cut to the size of the glass, to place between the paper and the back of the

frame, in order to equalise the pressure and secure good contact between the paper and the negative.

Care must be taken that the negative is thoroughly dry, and that no splashes of rain or other water get on to either the negative or the paper, for this almost invariably results in stains on the negative that are extremely difficult to remove.

The print-out processes, platinotype, and the iron processes, are usually carried out by daylight; alpha paper and bromide paper are almost invariably exposed to artificial light.

When printing with daylight, the printing frames should, as a rule, be exposed to diffused light, and not to direct sunlight. If the negative has been "doctored" in any way on the back, it *must* be printed in diffused light, since prints in direct sunlight would show the edges of the paper, varnish, etc. If a negative should be very dense, have very strong contrasts, or be deeply discoloured, then direct sunlight may be used.

The brightness of the light in which the printing is done affects the character of the print. With one and the same negative, printing in strong light tends to reduce the contrasts, whilst printing in weak light tends to increase them. Hard negatives should therefore be printed in a bright light, flat negatives in the shade. In the latter case considerable improvement is often effected by covering the whole of the printing frame with tissue paper or ground glass.

With all the processes, except alpha and bromide papers, it is necessary to examine the paper occasionally, in order to stop the action of light at the right time. In *a feeble light*, preferably inside a room, one of the hinged parts of the back is opened carefully, and the paper lifted by the edge or the corner and examined, great care being taken not to pull it or displace it in any way. It is also essential that the part of the back that remains down should not be disturbed, or when the paper is allowed to fall into its place, and the back is again fastened down, the paper will not return exactly to its original position, and a peculiarly blurred image will be the result.

Special printing dodges.—In addition to the plans already described for altering the character of the print by working on the face or the back of the negative, the method of printing can be made to contribute to the quality of the result. Parts of the negative that are too thin, for example, may be shaded by

means of a piece of card, but the latter must be kept moving, or its position will be shown by a distinct mark across the print. If the hight lights are very dense, and it is difficult to get detail in them without over-printing the shadows, take a piece of card sufficiently large to cover the whole of the frame, cut a small hole in it, and take the frame into direct sunlight, holding the frame and the card so that the hole in the latter allows the sunlight to fall on the high lights of the negative, whilst all the rest is protected. The card must be kept slightly moving. Modifications of these devices will suggest themselves after a little experience.

Vignetting may fairly be classed as a printing dodge. It consists in so arranging matters that the intensity of the image gradually falls off at the edges until it merges into the whiteness of the paper. Portrait studies, especially delicately lighted busts, and small landscapes with a considerable amount of detail, are the only subjects to which, as a rule, the method can be applied with pleasing results. A sheet of card or thin metal is attached to the printing frame at some distance above the negative, and in this screen is cut a hole, the size and shape of which depends on the nature of the subject. The frame is then placed in diffused light, and should be turned partly round from time to time as printing proceeds.

Directly under the hole the print of course acquires its full intensity, but towards the edges, where the paper is shaded by the card or metal, it becomes fainter and fainter. The further the vignetter is away from the negative the more gradual is the falling off in intensity, and *vice versâ* ; an effect similar to that resulting from distance is gained by turning up the edges of the aperture, or by serrating them with a pair of scissors—*i.e.*, cutting them so that they look like the edge of a saw. The thin sheet lead that is used for lining tea-chests makes excellent vignetting screens; it can be attached to the printing frame by bending it down over the edges, and its softness makes it easy to enlarge the aperture, turn up the edges, or alter its shape.

Printing in skies.—In some cases the opacity of the sky is such that the sky and the landscape print at the same time. More frequently, however, the sky is too opaque, and after the landscape is fully printed it must be shaded in the manner

indicated above, in order that the details of the sky may be obtained. In many cases, however, the sky is quite opaque, or possibly is not satisfactory in form or character and has to be blocked out (p. 86). Consequently in the print the sky is represented by a great patch of white, which is very inartistic. There are two ways of getting over this difficulty: one is to produce a plain gradated sky by "sunning down"; the other is to print in a sky with clouds from another negative.

Briefly, "sunning down" consists of exposing the print to light in such a way that the upper part of the sky receives the longest exposure, and the lower part the shortest exposure, the depth of tint therefore decreasing from the zenith to the horizon as it does in nature. If the sunning down is done through plain glass, or through no glass at all, the quality of the print in the sky will be different from its quality in the landscape, where the printing was done through the gelatine film. Proceed therefore in the following manner:—Expose a plate to light, develop, with the same developer that you use for negatives, until there is a slight deposit of silver, fix, wash and dry in the usual way. Use the plate thus prepared for sunning down. When the landscape is fully printed, the sky remaining white, place it in a frame behind the fogged plate, cover the frame with a piece of card, and place it in diffused daylight. Now gradually move the card down until the horizon of the landscape is reached, where the paper must only be allowed to acquire a slight tint. If the sky-line of the landscape is irregular, it must be masked by placing under the card some soft Turkey-red cloth, and roughly fitting it to the outline of the landscape, or by covering it with a mask of paper, prepared by making a print on albumenised or gelatino-chloride paper (which should be washed and dried, but need not be toned or fixed), and carefully cutting out the sky with a pair of sharp scissors. The mask may be attached to the sky-negative by means of strips of gummed paper at the edges, or in some more permanent manner if a large number of the prints is required. Considerable pains must be taken in fitting the mask accurately to the landscape, seascape, or whatever it may be.

Great care should be taken not to make the sky too heavy.

Clouds.—Gradated skies often answer very well for small

pictures, but for large pictures it is desirable that the sky should show some detail, and cloud-forms are frequently required to balance the landscape, etc. A collection of cloud-negatives should be made, using slow plates, and giving short exposures with a small stop. Develop with a lower proportion of alkali than usual, and keep the negative somewhat thin, with good contrasts. A good series should include clouds of various forms taken under various conditions of lighting.

It is absolutely necessary that the lighting of the clouds should correspond with the lighting of the landscape, and the clouds and the landscape should be taken with the same lens, or with lenses of nearly the same focal length. A cloud negative should always show part of the landscape, in order that the proper relative height of the clouds above the horizon may be preserved. When the landscape has been printed, the cloud negative is placed in a printing-frame and the landscape adjusted so that the clouds come in the proper position. This is easier to do if a printing-frame larger than the cloud-negative, and fitted with plate glass, is used.* The landscape is masked with red cloth, or with a paper mask in the manner already described, and care should be taken not to print the sky too deeply. In some cases it is necessary to sun down in the same way as if a plain sky were being printed, and if this is not done it is desirable to move the edges of the cloth from time to time, in order to prevent the appearance of any hard lines. In almost all cases, except perhaps with storm-clouds, the sky should be darkest at the top, and should become lighter and lighter towards the horizon, where it should be either quite white or only slightly tinted, save in the case of mountain scenes, where the horizon is very high.

* It facilitates the selection and arrangement of the clouds, if the cloud negative is two or three sizes larger than the landscape negative, provided that they were taken with lenses of about the same focal length.

CHAPTER XI.

PRINTING ON GELATINO-CHLORIDE PAPER.

GELATINO-CHLORIDE paper is coated with an emulsion of silver chloride and other silver salts in gelatine, and usually has a smooth and somewhat bright surface, but can also be prepared with an unglazed or "matt" surface. The former is invaluable when minute or delicate detail has to be rendered, whilst the latter gives a broader, and for some purposes a more artistic, effect.

Ilford Gelatino-chloride Printing-out Paper (P.O.P.) can be obtained with a glazed surface (either white, mauve, or pink) or with a matt surface, and a "special" paper is also made for giving soft prints from "hard" negatives. The last property is especially valuable when dealing with under-exposed negatives, which are not uncommon in studio work.

The paper must be carefully protected from damp, dust, and an impure atmosphere, and will retain its good qualities for a considerable time, but must not be kept too long. It should be stored in a well-closed tin or cardboard case, or in a wrapping of pure paper.

The paper is sold in sheets measuring $24\frac{1}{2} \times 17$ inches, and may also be bought ready cut to the ordinary sizes. It must not be handled with moist or dirty fingers, and the sensitive surface must be touched as little as possible.

The general principles to be followed in printing are explained in the preceding chapter. The depth or intensity that the prints should have before being removed from the frames depends to some extent on the toning bath that is going to be used. With the sulphocyanide bath that is recommended the prints should be only a very little deeper than they are required to be when finished, since there is very little reduction in intensity during the subsequent operations.

The prints may be finished off at once, or may be kept, with due precautions, for several days. They are first thoroughly washed with soft water, until all the soluble silver salts are removed, a condition that is indicated by the wash water remaining quite clear. The prints will now be red or brownish-red, and if simply fixed would have an unpleasant colour when dry. This is obviated by depositing on the image, which consists

of altered silver salts, a certain quantity of metallic gold. The operation is known as "toning," and the colour of the toned prints depends on the quantity of gold that is allowed to deposit on the red image, and on the colour of gold, which is determined by the rate at which the deposition takes place.

Many different toning baths or solutions may be used, and it is possible to use a combined toning and fixing bath, but such a course cannot be recommended, because the permanence of the resulting prints is always doubtful. It is much better to keep the operations of toning and fixing quite independent of one another.

Gold for this purpose is sold in the form of gold chloride, sealed up in small glass tubes, each of which contains 15 grains of the compound. One of these is broken, and the contents dissolved in 15 ozs. of *distilled* water, in order to make a "stock solution of gold," every ounce of which contains 1 grain of gold chloride, or 1 part in 440.

Some saline substance is essential which will combine with the chlorine of the gold chloride, and thus promote the deposition of gold, whilst preventing any material reduction in the intensity of the image. The best substance to use for this purpose with gelatino-chloride paper is *ammonium sulphocyanide*, a white crystalline salt that dissolves readily in water.

The details of manipulation and method of preparing the toning baths are as follows :—

Preliminary Washing.—The prints are placed face upwards in a large dish of water (preferably soft water if it can be obtained), and as soon as the water becomes milky, which takes place rapidly, it is poured away, in order that the soluble silver salts removed from the paper may not have time to act on the gelatine, and thus possibly produce discoloration. A second quantity of water is then added, and allowed to act for a longer time, but is poured away as soon as it becomes distinctly milky. A third quantity of water is added, and allowed to act for a still longer time, and the process is continued until the prints have been washed in not fewer than six changes of water, and the last wash water is quite free from milkiness.

If the washing can be carried on in running water, so much the better; it must be continued until the water is quite free from milkiness as it runs away from the prints.

Whichever method is used it is of the greatest importance that the prints should be prevented from sticking together, so that the water can act freely on both surfaces. They must therefore be kept in continual motion.

In this and all other washings or similar operations (such as fixing), the best plan is to start with all the prints face upward, then turn them one by one face downward, until all have been moved. Next turn them in a similar way face upward again, and keep repeating this operation until the washing, etc., is completed. By working in this systematic way, every print will receive proper attention.

Hardening Bath.—In order to secure regularity of toning, and also to harden the film (which is very important in hot weather), the washed prints are immersed in a solution of common salt and alum.

Common salt	1 oz.	2 parts.
Alum	$1\frac{1}{2}$,,	3 ,,
Water, *up to*	20 ozs.	40 ,,

They should remain in this bath from five to ten minutes, and must be kept moving in the manner described above. They are then thoroughly washed in water in the same way, and are ready for toning.

Toning Bath.—It is convenient to keep the gold chloride and the sulphocyanide in the form of somewhat strong solutions, from which the bath can be made up.

STOCK GOLD SOLUTION.

Gold chloride	15 grs.	1 part.
Distilled water	15 ozs.	440 parts.

STOCK SULPHOCYANIDE SOLUTION.

Ammonium sulphocyanide	100 grs.	10 parts.
Water	10 ozs.	440 ,,

ORDINARY TONING BATH.

Gold chloride	2 grs., or	Stock solution	2 ozs.
Ammonium sulphocyanide	20 ,, ,,	,, ,,	2 ,,
Water	20 ozs., ,,	Water, *up to*	20 ,,

(Add the gold chloride last.)

A special toning bath is recommended by the Ilford Company, for warm tones as giving fine results with certainty and with freedom from "double tones." It is especially

useful with the Ilford Special P.O.P. The peculiarity of this bath lies in the fact that it contains a small quantity of sodium sulphite. It is important that the quantity of the latter should not exceed that given in the formula, and it is also important that the sulphite solution should be freshly made each day by dissolving in water the requisite quantity of a freshly crushed transparent crystal of sulphite.

STOCK SULPHITE SOLUTION.

Sodium sulphite	10 grs., or		1 part.
Water	10 ozs., ,,		440 parts.

SPECIAL TONING BATH.

Gold chloride	2 grs., or	Stock solution	2 ozs.
Sodium sulphite	$1\frac{1}{2}$ to 2 ,,	,, ,, ,,	$1\frac{1}{2}$ to 2 ,,
Ammonium sulphocyanide	20 ,,	,, ,, ,,	2 ,,
Water	20 ozs.,	,, Water *up to*	20 ,,

When the special bath is used, the sulphite should be added *last*, just before toning.

The ordinary bath may be thrown away after toning each batch of prints, or may be strengthened from time to time by addition of more gold shortly before use or during use, and thus be used over and over again. This method is only recommended when toning is carried on every day, and the strengthening should not be repeated too often, because the bath gradually becomes charged with impurities. It must always be filtered before use if necessary, and a fresh bath should be make up as soon as it shows signs of producing any stains or of working irregularly in any way whatever.

The special toning bath cannot be used repeatedly in this manner because the sulphite alters rapidly when the liquid is exposed to the air in dishes. If it is necessary to strengthen this bath *during use*, the following strengthening solution may be employed :—

Stock gold solution	4 ozs.	4 parts.
Stock sulphocyanide solution	2 ,,	2 ,,
Stock sulphite solution	2 ,,	2 ,,
Water	10 ,,	10 ,,

It is not desirable to make up more of this solution than is likely to be required, but if the sulphite is only added just

before use, and to the portion that is to be put into the bath, the other ingredients may be kept ready mixed for some days.

The strengthening solution should be added in small quantities to the bath when it begins to tone very slowly.

Toning is carried on either in weak daylight or by artificial light, and on the whole the latter is better, because it is more constant. A porcelain dish should be used, and should be kept for this purpose only. If the dish is large enough, four or five prints can be toned at the same time. They are immersed in the toning solution one by one, care being taken that no air bubbles form on their surfaces, and are kept in constant motion. It is important that the prints should not stick together. The colour gradually changes to brown, then to purple, and finally to a slaty blue. They must be carefully watched. Experience alone will enable you to decide when the prints should be removed from the bath. The shorter the time during which they remain, the warmer or redder will be the colour of the finished prints; and the longer they remain, the bluer or colder will they be. Upon removal from the toning bath the prints are rapidly rinsed with water in order to prevent continuance of the toning, and after being washed in four or five changes of water they are ready for fixing.

The fixing solution contains

Hypo	2 ozs.	1 part.
Water, *up to*	20 ,,	10 parts.

That is to say, it is a solution of hypo. (sodium thiosulphate) one-quarter the strength of that used for fixing negatives.

The prints should remain in the fixing solution from 10 to 15 minutes, and must be kept constantly moving, great care being taken that they do not stick together. After fixing* they are washed in running water for two hours, or, if running water is not available, in many changes of water, each quantity being thoroughly drained off before the next quantity is added. In either case care must be taken to keep the prints separated.

In order to dry the prints they are placed *face upwards* on blotting-paper, or a clean cloth, in a place free from dust. Nothing should be allowed to come in contact with the wet

* It is a good plan to put the prints that are supposed to be fixed into a second quantity of hypo. solution, in order to insure complete removal of the soluble silver compounds.

gelatine surface, or the two will adhere firmly when the print is dry. The prints may be suspended from a line by means of clean *wooden* clips attached to one corner.

Throughout all the manipulations the solutions should be kept as cold as possible, but the temperature of the toning-bath and fixing-bath should not be below 60° Fahr.

In warm weather, if the gelatine tends to become soft, it is necessary to immerse the prints in alum solution, either before toning or after fixing, but the alum must be very thoroughly washed out before the prints are put into any other solution. This treatment with alum is always advantageous, though not necessary, if the prints are to be mounted; it is absolutely essential if they are to be enamelled or burnished.

Gelatino-chloride paper will give passable prints even with indifferent negatives, but good prints, capable of acquiring a good colour in the toning-bath, and retaining their vigour after fixing, can only be obtained from good negatives.

The chief defects (not arising from the character of the negative) that are likely to be met with are as follows :—

Red patches that refuse to tone arise either (1) from handling the paper with moist or greasy fingers, or (2) from defects in the emulsion.

Unevenness of colour is caused by allowing the prints to stick together in the toning-bath.

Refusal to tone (partial or complete) arises from absence of sufficient gold from the toning-bath ; use of a very old toning-bath that has become largely contaminated with organic matter from previous batches of prints ; introduction of small quantities of hypo. into the toning solution.

A brown discoloration, visible of course more particularly in the whites of the prints, and appearing whilst washing between toning and fixing, or possibly, in rare cases, during toning, is due to the introduction of small quantities of the fixing-bath or solid hypo. into the liquid (see Appendix, p. 207). It is never advisable to begin fixing until all the prints have been toned and washed.

The advantages of gelatino-chloride paper lie in the ease of manipulation, the perfect manner in which it renders fine details, and the transparency of the shadows. In the character of the results, and in the method of working, it resembles the

older albumenised paper, but it has the great advantage that the prints are much less liable to fade.

Self-toning Paper.—With a view to reduce the difficulties of toning, various "self-toning" papers have been made from time to time. Late in 1902 Kalona, the Ilford self-toning paper, was produced. This paper considerably simplifies the process of toning as described on p. 99. It is sufficient to keep the prints moving for five minutes in the bath given below, and they will be evenly and uniformly toned.

Printing is done in the same way as with P.O.P. The prints are then, *without previous washing*, slipped quickly, one by one, face upwards, into a bath containing

Powdered alum . .	$1\frac{1}{2}$ oz. . .	33 parts.
Ammonium sulphocyanide .	20 grs. . .	1 part.
Water	20 ozs. . .	440 parts.

and are kept in constant motion in it for five minutes. They are next washed for 10 minutes in running water or in many changes of water and fixed for 10 minutes in a solution of hypo., 3 ozs. (15 parts); water, 20 ozs. (100 parts). They are finally washed in the same way as P.O.P. prints. The prints may be burnished or enamelled on glass or ferrotype plates.

For convenience the following stock solutions may be prepared, and the bath made up from them as required :—

No. 1.	Powdered alum . . .	8 ozs. . .	8 parts.
	Water	100 " . .	100 "
No. 2.	Ammonium sulphocyanide .	100 grs. . .	10 parts.
	Water	10 ozs. . .	440 "

Mix 18 ozs. of No. 1 with 2 ozs. of No. 2.

The process is so simple that few defects are likely to be met with, but imperfect washing between the alum and sulpocyanide bath and the fixing bath will lead to uneven light bluish-grey or greenish tones, due to a residuum of alum in the prints. The dishes and the hands must be scrupulously clean. If the instructions are carefully carried out the prints will be as permanent as those on Ilford P.O.P.

In tropical climates the following bath may be substituted for the above bath if necessary :—

Chrome alum	20 grs.
Ammonium sulphocyanide	20 "
Water	20 ozs.

CHAPTER XII.

PRINTING ON ALBUMENISED PAPER.

THIS is one of the oldest, and hitherto has been the most widely used, of all the photo-printing processes, but there can be little doubt that it is being displaced by the gelatino-chloride paper.

Paper of the purest quality is coated with a layer of albumen containing some soluble chloride, and after drying is floated on a solution of silver nitrate, which converts the soluble chloride into silver chloride, the albumen into silver albumenate, and leaves these products on the surface of the paper, together with an excess of silver nitrate.

The precautions necessary in keeping and handling the paper, and the general details of the manipulations, are precisely the same as with the gelatino-chloride paper.

The toning bath contains gold chloride, together with some salt capable of absorbing the chlorine, just as in the case of gelatino-chloride paper. Sulphocyanide cannot, however, be recommended for use with albumenised paper; but sodium acetate, borax, sodium bicarbonate, and sodium tungstate all give good results. In no case should the temperature of the toning bath be below 60° Fahr., and all of them work better at 65° or 70° Fahr.

The *sodium acetate bath* is made up as follows :—

Sodium acetate . .	60 grs. . .	30 parts.
Gold chloride . .	2 grs.* . .	1 part.
Water *up to* . .	20 ozs. .	4400 parts.

The solution must be made at least a day before it is to be used, and sufficient precipitated chalk must be added to make and keep the liquid quite neutral. It will keep for a long time, and may be strengthened by the addition of more gold solution when necessary, but should be tested now and again for acidity,† and shaken if necessary with some more chalk.

The *borax bath* may contain :—

Borax	90 grs. . .	90 parts.
Gold chloride . .	1 gr.* . .	1 part.
Water, *up to* . .	20 ozs. .	8800 parts.

* Or stock gold solution, 1 oz. for each grain.

† A strip of blue litmus paper immersed in it is changed to red.

The borax solution alone may be kept for any length of time, but the gold solution should be added to it just before use. During toning more gold may be added if necessary, in small quantities at a time. If the used bath is kept it soon precipitates any gold that may have been left in it, and therefore a fresh bath should be made up each time. Over-toning is much less likely to occur with the borax bath than with the acetate bath.

The *bicarbonate bath* :—

Sodium bicarbonate	10 grs.
Gold chloride	2 grs.*
Water, *up to*	20 ozs.

The bicarbonate solution may be kept for a long time, but the gold chloride must be added just before use, and a fresh bath must be prepared each time that a batch of prints has to be toned.

The *sodium tungstate bath* :—

Sodium tungstate .	30 grs. . .	4 parts.
Gold chloride . .	2 grs.* . .	0·25 part.
Water, *up to* . .	20 ozs. .	1000 parts.

This bath can be kept ready mixed, but it is not advisable to use the same quantity more than once.

The prints should be very thoroughly washed before toning, and the last wash water should show no trace of milkiness. Care must be taken not to over-tone, especially when using the acetate or bicarbonate bath. On removal from the toning-bath the prints should be placed in a large dish of water.

Fixing, washing, and drying are done in the same way as with the gelatino-chloride paper. Thorough washing is essential, but very prolonged washing is injurious, reduces the vigour of the prints, and tends to make them fade.

The faults likely to be met with are similar to those found with the gelatino-chloride paper. If the acetate bath is used, refusal to tone may be due to acidity of the toning-bath.

The great defect of prints on albumenised paper is their want of permanence. Deterioration is of two kinds: (1) the print gradually becomes yellow, and possibly even brown, all over, the change of course showing most in those parts which should remain white; (2) the image itself gradually fades.

* Or stock gold solution, 1 oz. for each grain.

The first result is due to imperfect fixing, arising from the use of too weak a solution of hypo.; or to insufficient washing after fixing. The cause of the second result is not yet accurately known; it may be due to different causes in different cases. The fading occurs more frequently with mounted prints than with those that are left unmounted; in some cases it is accelerated by insufficient washing, but, on the other hand, very long washing is injurious; it is promoted by the use of sour paste, or acid glue or gelatine, for mounting; it not infrequently arises from impurities in the mounts; it is much less liable to take place if the prints are kept perfectly dry.

CHAPTER XIII.

PRINTING ON BROMIDE PAPER.

BROMIDE PAPER is paper covered with gelatino-bromide emulsion, similar to that used for the preparation of plates, but, as a rule, less sensitive. The paper requires the same care as plates with respect to storage and protection from white light; but, in consequence of the lower sensitiveness, a brighter and a yellower light may be used in development and other operations than would be safe with ordinary plates.

Ilford Bromide Paper is made of two degrees of rapidity—namely, "slow," which should be used for contact printing and daylight enlargements; and "rapid," which is intended for the making of enlargements by either daylight or artificial light, though it may also be used for printing by contact. Each emulsion is spread on two different kinds of paper, one with a rough surface and the other with a smooth surface, so that we have "rough slow," "smooth slow," "rough rapid," and "smooth rapid." As a rule, the smooth paper should be used for small prints, or for subjects where minute detail must be shown, whilst the rough paper is better for large prints and subjects in which subordination of the detail increases the artistic effect. They all have a matt surface, and therefore are specially adapted to working up with either brush or pencil.

A third variety of the Ilford Bromide Paper is the Platino-Matt-Surface (P.M.S.), which is coated on a special smooth

thick paper, and gives prints having qualities not obtainable on the other varieties of bromide paper.

Negatives for bromide printing should not have very strong contrasts, and the shadows should show a considerable amount of detail. The character of the print can be made to vary very considerably by altering the conditions of exposure; and a negative that is too thin or weak in contrast to give even a passable print by other methods can often, by careful printing, be made to give a very fair print on bromide paper.

Exposure is made to gas or lamp light in an ordinary printing frame. Care must be taken that there is no dust on the surface of the negative. It is sometimes difficult, in the light of the developing-room, to be certain as to which is the sensitive face of the bromide paper; but if the sheet is left exposed to the air for a short time, it will curl slightly at the edges, and the face that curls inwards is the sensitive face, and should be placed in contact with the negative.

Any gas flame or lamp will serve for making the exposure, but it is advisable always to use the same lamp or burner, with the flame turned up to the same height, in order to simplify the estimation of the exposure. Where gas is available, the most convenient plan is to use a "matchless" burner, which can be screwed into an ordinary gas bracket in place of the common burner. Turn the tap of the bracket full on, and regulate only with the tap on the burner. It is much better to have a matchless burner fixed to the end of a board, about 4 feet long, 4 inches wide, and 1 inch or $\frac{3}{4}$ inch thick, the burner being connected to a gas supply by means of flexible indiarubber tube. On the board itself are marked definite distances from the flame—6 inches; 1 foot; 18 inches; 2 feet; 3 feet; 4 feet (fig. 37). It is then easy to place the printing frame at any desired distance from the flame, and if necessary a small block of wood may be placed behind the frame in order to keep it in an upright position.

The time of exposure is determined by the character of the negative and its distance from the flame. Roughly, the exposure required varies as *the square* of the distance: for example, twice the distance, four times the exposure, and three times the distance, nine times the exposure. The best distance depends on the nature of the negative and the character of

the print required. Hold the negative between your eye and the flame at some distance from the latter, and gradually reduce the distance until the details in the high lights (*i.e.*, the most opaque parts of the negative) become visible; harsh contrasts and chalky lights will be obtained if the printing is carried on at any greater distance. As already stated, to print in a bright

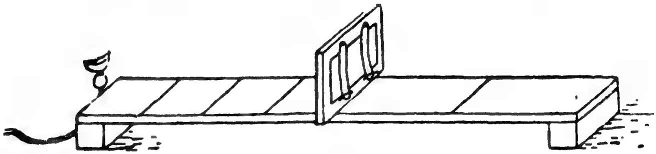

FIG. 37.

light—*i.e.*, near the flame—tends to reduce the contrasts; and to print in a feeble light—*i.e.*, a long way from the flame—tends to increase the contrasts. It follows that negatives with strong contrasts should be printed near to the flame, whilst negatives with weak contrasts should be printed at a considerable distance. For average negatives 18 inches from the flame is a suitable distance; but large negatives must be kept farther away, or must be kept moving from side to side, and up and down, during the exposure, in order to secure even illumination.

It is difficult to give any useful estimate of the time of exposure, but an average negative, not stained, at a distance of 18 inches, will require about 10 seconds with a good No. 5 gas burner, with Ilford slow bromide paper. Rapid paper is about 5 or 6 times as quick. Classify your negatives, according to their character and opacity, into five or six groups, and after a little practice you will soon be able to estimate the exposure with considerable accuracy. When once you have found the best distance and exposure for any negative, make a note of it.

Development.—The image has to be developed in much the same way as a negative, but pyro. cannot be used with the best results on account of the unsatisfactory colour of the image. The orthodox developer for bromide paper is ferrous oxalate, though others, such as ortol, quinol, metol, and amidol, are often employed.

With ferrous oxalate the colour of the image shows very

little tendency to variation, and a large number of prints practically identical in appearance can be obtained without any special difficulty.

Some little difficulty is experienced with the oxalate developer when the water supply is "hard," because of the production of a white precipitate of calcium oxalate, the amount of it depending on the degree of hardness of the water. Since, however, the precipitate is white, its effect on the print is not noticeable except in the case of very hard waters. In the case of lantern slides the effect is more marked, and the slide appears opalescent. The precipitate is formed if the developer is diluted with the water, and also during the early stages of washing. The difficulty is of course removed by using soft water, if it can be obtained, for diluting the developer, and for the first two or three wash waters. When soft water is not at hand, some of the hard water should be boiled for half an hour, and can then be used for the purposes named, after it has cooled and has become clear by settling or filtration.

Development with Ferrous Oxalate.—Ferrous oxalate is a yellow solid substance that will not dissolve in water, but dissolves readily in a solution of potassium oxalate, forming a deep orange-red solution. It possesses considerable reducing power, owing to its tendency to change into ferric oxalate. The solution of ferrous oxalate for use as a developer may be prepared by dissolving ferrous oxalate in a solution of potassium oxalate, but it is usually made by adding a solution of ferrous sulphate (protosulphate of iron) to the solution of potassium oxalate.

The way in which the two solutions are mixed, and their relative proportions, are points of great importance. If the oxalate solution is gradually added to the iron solution, a yellow precipitate of the ferrous oxalate at once begins to separate, and it will not re-dissolve except upon addition of a considerable quantity of oxalate solution and vigorous shaking. If, on the other hand, the iron solution is poured into the oxalate solution, so that the latter is in excess, the dark orange liquid that is formed remains clear up to a certain point; but if the addition of the iron is continued beyond this point, the precipitate of ferrous oxalate begins to separate.

These facts lead to two maxims that should always be borne in mind. (1) Always add the iron solution to the oxalate solution, and not *vice versâ*; (2) be very careful to avoid adding too large a proportion of iron solution. When a precipitate does form, it can usually be re-dissolved by adding more of the oxalate solution.

Three solutions are required for the compounding of the developer :—

OXALATE SOLUTION.

Potassium oxalate .	10 ozs.	1 part.
Potassium bromide	20 grs.	0·005 part.
Water, *up to* .	40 ozs.	4 parts.

The salt is dissolved in about three-quarters of the full quantity of hot water, filtered if necessary, and made up to the proper volume by adding more water after the solution has become cold.

IRON SOLUTION.

Ferrous sulphate	$2\frac{1}{2}$ ozs.	1 part.
Water, *up to*	10 "	4 parts.
Sulphuric acid .	15 drops .	Small quantity.

The ferrous sulphate must be in pale green crystals without any brown coating, and should be kept in well-corked bottles. Before being dissolved, it should be finely powdered ; the water used may be warm, but must not be very hot, and the sulphuric acid should be added to the water at the beginning. Use about three-quarters of the full quantity of water for preparing the solution, and make up to the proper volume after it has cooled. The solution gradually becomes useless if exposed to the air, and it should be kept in small bottles, holding not more than two ounces each, and they should be filled up to the neck and tightly corked.

Add one part of the iron solution to four parts of the oxalate solution immediately before use. If necessary a few drops of a 10 per cent. potassium bromide solution may be added, but not more than 10 drops to each fluid ounce.

It is perhaps worth noting that four parts of the oxalate solution contain one part of potassium oxalate, four parts of the iron solution contain one part of ferrous sulphate, and the two solutions are mixed in the proportion of four parts to one.

Soak the exposed paper in water for two or three minutes, pour

off the water, and pour on the developer. Some little time elapses before the image begins to appear, but it then comes up quickly. As soon as the proper amount of detail in the high lights is visible, remove the paper from the developer, and quickly immerse it in a clearing solution composed of,—

Acetic acid	½ oz.
Water	80 ozs.

Acetic acid has the advantages that it is readily obtained, is non-poisonous, and can be measured out instead of being weighed. Oxalic acid is, however, by far the most efficient of all the substances that may be used for the removal of iron salts from paper, and it can be used in the following form :—

Oxalic acid	180 grs. .	. 1 part.
Water, *up to* . . .	40 ozs. .	100 parts.

The print must only remain for a short time in either of these solutions, and must then be quickly and thoroughly washed. The same quantity of clearing solution must not be used for a large number of prints. The iron solution that is carried by the print into the clearing solution rapidly becomes changed into a ferric salt by the action of the air, and the ferric salt will seriously reduce the intensity of the image, if the latter is allowed to remain in the liquid too long.

If the prints, when removed from the developer, are put into plain water without previous washing in the acid solution, they are very likely to be stained brown, owing to the precipitation of oxide of iron in the film and paper. Should this happen, the stain can generally be removed by immersing the print (after treatment with alum) for some time in a weak solution of oxalic acid, and afterwards thoroughly washing with water.

The same developer can be used for several prints, but gradually becomes slower in its action, and tends to give stronger contrasts. In printing from negatives weak in contrast it is desirable to use some old developer, strengthened if necessary by the addition of some freshly mixed. The colour of the image is a good black. If the developer is mixed with an equal bulk of water, the colour of the print is a somewhat warmer black, but development is slower, and a slightly longer exposure is required. The ferrous oxalate developer gives comparatively little power of correcting for errors in exposure.

If the print shows signs of over-exposure, dilute the developer with water, or add a large proportion of bromide, the restraining influence of which is considerably greater than with pyro.

An alternative method of development is as follows :—

No. 1.		No. 2.	
Metol	50 grs.	Sodium Carbonate (crystals)	½ oz.
Hydroquinone	25	Potassium Bromide	30 grs.
Sodium Sulphite	1 oz.	Water, *up to*	20 ozs.
Water, *up to*	20 ozs.		

Mix in equal volumes immediately before use. No clearing solution is necessary when this developer is used.

Ortol also gives excellent results if used according to the author's formula, and yields warm, black images. The developer for negatives (p. 74) is diluted with an equal volume of water. Several prints may be developed in the same quantity of developer, and no clearing solution is needed.

If it is desired to use quinol, one of the developers given for negatives (p. 71 and 72) should be diluted with its own volume, or half its own volume, of water. The disadvantage of this developer for bromide paper is that the detail in the shadows is apt to be lost, and if development is slow, the black colour of the image often acquires a greenish tint.

When copies of line subjects, such as plans or tracings, are required in a hurry, bromide paper developed with metol-hydroquinone, ortol, or hydroquinone affords a rapid and easy means of preparing them, since several prints can be developed in the same dish at the same time, and a comparatively large number of prints can be developed with the same quantity of solution.

Fixing.—After removal from the acid clearing bath the prints must be thoroughly washed, so that all trace of acid is removed, and are then fixed in an ordinary hypo. solution (20 in 100), a fresh quantity being used for each batch of prints.

Stains.—Great cleanliness is absolutely necessary when working with ferrous oxalate. If the solution, or a print moistened with the solution, comes in contact with a trace of pyro. or quinol, a black stain is produced. If a small quantity of hypo. gets into the developer, black or brown stains are formed on the prints, and cannot be removed. This result is produced by

such small traces of hypo. as may come from wiping the fingers on a duster that has been wetted with hypo. solution, and from touching with the fingers splashes of hypo. that have been allowed to dry on the working table. The best plan is to develop, clear, and wash the whole batch of prints before even pouring out the hypo. that is to be used for fixing.

Drying bromide prints.—Nothing must be allowed to come in contact with the wet gelatine surface, and the prints must be allowed to dry, face upwards, on a clean cloth or blotting paper, in a place as free from dust as possible; or they may be suspended from a line by means of clean *wooden* clips gripping the prints at one corner.

Faults in bromide prints.—Some of the faults, including want of contrast, too much contrast, etc., are identical with those observed in negatives, and arise from the same causes.

Yellow stains, in patches or all over the print, may arise from one of two causes: (1) from putting the print out of the developer into plain water, instead of into the acid clearing bath—the stain being due to peroxide of iron, and removable by treatment with oxalic acid solution; (2) from imperfect removal of the acid before putting the print into the fixing bath—the stain in this case consisting of silver sulphide, which it is almost impossible to remove without destroying the image.

The lights of the print are at first white, but gradually become yellow.—This arises from imperfect fixing, or from imperfect washing after fixing; the stain consists of silver sulphide.

Properly prepared bromide prints may be regarded as permanent under all ordinary conditions.

Bromide Opals.—Opal glass cut to the same size as the paper can be obtained coated with the same emulsion as the Ilford Bromide Paper. The exposure and manipulations are the same, the chief points being to avoid under-exposure and over-development. If the film shows any tendency to frill, proceed in the same way as with negatives.

Toning Bromide Prints.—Many attempts have been made to change the black or blue-black colour of gelatino-bromide prints into a warm black, brown, or red. A dilute quinol developer, as previously stated, will give a brown image; mercurial intensification (p. 76) also changes the colour of the ordinary black image to warm brown or dark brown, but

both the colour and the permanency of the result are uncertain; treatment with uranium ferricyanide gives a colour varying from warm black to brown red, according to the time during which the solution is allowed to act. The uranium method is the only toning method that can be regarded as giving satisfactory results with bromide prints. Two solutions are required:—

1.—Uranium Solution.

Uranium nitrate	20 grs. . . .	1 part.
Acetic acid	½ oz. . . .	11 parts
Water, *up to*	10 ozs. . . .	220 „

This solution will keep for a long time.

2.—Ferricyanide Solution.

Potassium ferricyanide* .	20 grs. . . .	1 part.
Acetic acid	½ oz. . . .	11 parts.
Water, *up to*	10 ozs. . . .	220 „

This solution must be freshly prepared, or must be kept in the dark.

The prints are best developed with metol-quinol (or ortol) and not with ferrous oxalate. After fixing they are very thoroughly washed, immersed in alum solution for ten minutes, again well washed and dried. They are then immersed in water until thoroughly wetted; the water is poured off, and the prints are covered with a freshly made mixture of the uranium and ferricyanide solutions in equal proportions. The action begins at once, and the colour of the image gradually becomes redder and redder. As soon as the desired colour is obtained, the print is removed from the toning solution and rapidly washed, the washing being continued until all trace of yellowness disappears from the high lights of the image and the edges of the paper.

Instead of pouring the toning solution of the print into a dish, the wet print may be placed on a sheet of glass, and the toning

* That is, red prussiate of potash. Potassium ferrocyanide, or yellow prussiate of potash, must not be used. Even when in the solid state it is better to keep the ferricyanide in the dark. Before weighing out the quantity required for the solution, any yellow powder on the outside of the crystals should be carefully wiped off with a clean damp cloth. Pure potassium ferricyanide is dark red, and transparent.

solution applied to the surface only with a plug of cotton wool or a camel's hair brush.

The process is based on the fact that uranium ferricyanide is a soluble compound, but uranium ferrocyanide is an insoluble compound of a deep chocolate red colour. In contact with the metallic silver that constitutes the image, the ferricyanide is converted into ferrocyanide, with the result that uranium ferrocyanide is deposited in place of the original silver, the colour becoming redder and redder as the black silver is more and more completely displaced by the uranium compound. When the action is complete the image consists of uranium ferrocyanide and silver ferrocyanide. As a rule, however, only part of the silver is acted upon, and the image consists of these two compounds, together with unaltered silver.

The presence of acetic acid is necessary in order to keep the whites of the image clear. It has, however, a tendency to soften the gelatine, and hence the necessity for treating the print with alum.

If the print is not thoroughly washed after fixing, uranium ferrocyanide will be deposited all over the surface, and the print will be stained. Treatment with alum not only hardens the gelatine, but also destroys any traces of hypo. that may be left in the paper, and thus lessens the risk of staining.

Uranium ferrocyanide is easily soluble in alkalis, and hence the toning can be completely removed by immersing the print in water containing ammonia, caustic soda, or sodium carbonate, the intensity of the silver image that remains depending on the extent to which the toning has been carried.

When warm tones are desired in contact prints the author greatly prefers and recommends alpha paper, which gives better results with greater certainty and less trouble. The chief value of uranium toning lies in its applicability to enlargements.

ALPHA PAPER.

Alpha emulsion can be obtained to order, coated on paper with either a rough or a smooth surface, the sizes and prices being the same as in the case of Ilford Bromide paper.

For developing Alpha paper the ferrous oxalate developer should be used, the general principles and the mode of manipulation being precisely the same as in the case of bromide paper; the differences are that a weaker developer must be used, or the paper will fog, and a much greater quantity of light, which should also be yellower and less orange, must be used.

If it is desired to use hydroquinone for development, the developers given for negatives should be diluted with from four to six times their volume of water. As in the case of bromide paper, the range of gradations is often less satisfactory than with ferrous oxalate.

The ferrous oxalate developer requires the greatest cleanliness, and the most scrupulous care to avoid contact with the slightest trace of hypo.: and this is its chief drawback when compared with the quinol developer, although it gives, as a rule, a better range of gradation and greater clearness of the shadows.

The formula* is

Oxalate solution	4 parts.
Iron solution	1 part.
Water	15 parts.

To this add 10 minims of potassium bromide solution for each ounce of oxalate solution taken.

The prints may be put into the developer whilst dry, or they may first be wetted. Several prints may be developed at once if they are kept separated and moving. Development is somewhat rapid, and care must be taken not to over-develop; the prints should be removed before they show quite all the detail or intensity that is required, since development continues to a slight extent during the first stage of washing. If difficulty is experienced in controlling the operation, use a mixture of old developer (which should be kept in a well-corked bottle, filled up to the neck) with some new developer. The greater the proportion of old developer, the stronger will be the contrasts in the resulting prints. When development is complete the prints must not be put into water, but

* For the general properties of the ferrous oxalate developer, the method of using, etc., see under BROMIDE PRINTING, p. 107.

must be immersed for *short time* in the acid clearing solution p. 109, or in

Alum solution (p. 67)	1 part.
Water	6 parts.
Sulphuric acid	5 drops per oz.

They are then thoroughly washed, and are toned and fixed in exactly the same manner as Alpha lantern plates (see p. 147).

GASLIGHT PAPERS.

Gaslight papers are papers which are practically insensitive to diffused gaslight or lamplight, and can consequently be worked by such light, provided that they are kept about six feet from the burner, or, if nearer, are shielded from the direct light. This is obviously a great convenience, since no special lamp is needed, and the work can be carried on in an ordinary room. If the paper is exposed behind a negative to bright gaslight or lamplight, a latent image is produced which can be developed in the ordinary way with a suitably compounded developer. As a rule the developers employed for bromide papers are not suitable for gaslight papers.

Ilford Gaslight Paper is sold in packets of cut size, in the same way as P.O.P. or bromide paper. The general details of manipulation are much the same as for bromide paper. The exposure required for an average negative is about 20 seconds, at a distance of six inches from an ordinary No. 5 gas-burner. Incandescent gaslight may be used with advantage, and in this case, even if the printing-frame is kept further away from the flame, the exposure will be less than with an ordinary burner. Lamplight or the incandescent electric light may also be used. Care should be taken in estimating the exposure, because with this class of paper success depends on timing the exposure so correctly that the image can be developed up quickly. By working in the systematic way recommended in the case of bromide paper, a little practice will remove any difficulties in the way of estimating the exposure.

Any of the developers generally used for this class of paper will answer with the Ilford paper, but the following formula is recommended :—

Metol	10 grains.
Hydroquinone (Quinol)	40 „
Sodium sulphite	1 oz.
Potassium bromide solution (1 in 10) .	20 drops.
Soda crystals	1 oz.
Water	20 ozs.

Dissolve the soda crystals separately in half the water, and the other constituents in the other half; mix the two solutions, and keep in a well-corked bottle. Be very careful to use a clean dish; cleanliness all through the operations is in fact essential. Use sufficient developer to completely cover the print without difficulty, and put the exposed paper face upwards in the dish, and pour the developer over it with the usual precautions. Development takes place rapidly, and is *complete in about* 30 *seconds*. Then rinse the print in water and place it in the fixing-bath. The developer may be used for several prints in succession, provided that it remains colourless and does not begin to act too slowly.

The fixing bath should contain—

Hypo	3 oz.	15 parts.
Water	20 oz.	100 „

and a fresh quantity should be used for each batch of prints. Care must be taken that the prints are completely immersed in the fixing bath and do not stick together, or yellow stains may be produced. Not less than 10 minutes should be allowed for fixing, and the prints should afterwards be washed in frequent changes of water or in running water for about an hour. The prints should be dried in the same way as bromide prints.

If the exposure has been correct and the operations have been properly carried out the prints are of a fine black colour.

Postcards, coated on one face with the gaslight emulsion, and requiring exactly the same treatment as the paper, can also be obtained from the Ilford Co.

CHAPTER XIV.

PLATINOTYPE.

THE platinotype process, of which there are several modifications, yields prints that have a matt surface and a pleasing black, or, with special treatment, sepia colour. The image consists of metallic platinum, which offers great resistance even to powerful chemical reagents; and consequently it may safely be taken that the pictures will be as permanent as the paper that they are printed on. In fact, so far as artistic appearance and permanence of results are concerned, platinotype is at present unsurpassed by any photographic printing process.

As a rule the paper is sensitised with a mixture of ferric oxalate (or a double oxalate) and a platinum salt. On exposure to light the ferric oxalate is converted into ferrous oxalate, with a change in colour and the production of a comparatively faint image. The ferrous oxalate is, however, in the solid state, and acts but little on the platinum salt. If now the print is immersed in a solution of potassium oxalate, the ferrous oxalate dissolves; but at the moment that it passes into solution it reduces the platinum salt to metallic platinum, which is deposited on and in the paper where the ferrous oxalate was. Since the quantity of platinum reduced depends on the quantity of ferrous oxalate present, and since the latter depends on the amount of light-action, the result is the production of a properly graduated image composed of reduced metallic platinum, and all that remains to be done is to remove from the paper the excess of platinum and iron salts.

Ilford Platona Paper is a platinum paper which is developed in cold solutions and yields prints of a black colour. The paper is issued in sheets or in cut sizes, and is packed in soldered tins. Enclosed in the tin with the paper is a lump of calcium chloride, for the purpose of keeping the air in the tube quite dry; but when once the tin has been opened the paper should be taken out and placed in one of the usual storage tubes sold for the purpose, which can be obtained

from all photographic dealers. Care must be taken that the calcium chloride in the storage tube is not itself damp.

One of the chief points in connection with platinum printing is to keep the paper as dry as possible, not only during storage, but during printing, and, in fact, up to the time when it is developed. If the paper is allowed to become damp, it is probable that the purity of the whites of the print will suffer, owing to slight chemical action that takes place in the damp (but not in the dry) paper, irrespective of any exposure to light.

It follows that the pads of the printing-frame, and any material placed behind the sensitive paper to ensure proper contact with the negative, must be as dry as possible; they should be placed in front of a fire, or in summer be exposed to the direct sunlight, for some time before being used. The safest plan, which the author always adopts, is to put a sheet of some waterproof material immediately behind the sensitive paper, and therefore between it and the pad; and in damp weather or in moist climates this precaution is indispensable. Paraffined paper, thin Willesden paper, thin sheet indiarubber, or the oiled sheets used in letter copying books may be used for this purpose.

It is obvious that these protective materials must not be kept in a place where they are liable to become surface damp. For the same reason care must be taken that the lid of the storage tube containing the paper is properly fastened.

The paper is very sensitive to light, and consequently all the manipulations, including the examination of the paper during the printing, must be done in the weakest light consistent with successful working. Artificial light may be used more freely than daylight, but prolonged exposure of the paper to artificial light will lead to degradation of the whites of the prints. With the electric arc light, prints can be made on the paper without requiring excessively long exposure.

The negatives used for platinum printing must be of good quality, with a fair degree of opacity, and good but not excessive contrasts. Thin and flat negatives will not yield good prints on any kind of platinum paper. On the other hand, no special type of negative is needed for the process,

provided that they are reasonably good; and negatives that will give really good prints on P.O.P. will also give first-rate prints on Platona paper if properly printed. Negatives with very strong contrasts, from which it is difficult to obtain satisfactory prints by any other process, will often yield useful results on Platona paper, especially if printed in sunlight.

As a rule, printing must not be carried on in direct sunlight, but in the shade; and thin negatives should be printed in the weakest light that is practicable.

The sensitive surface of the paper is easily recognised by its bright lemon-yellow colour. During printing, this lemon-yellow colour gradually changes, where the light acts, to a deep violet, and this in its turn eventually becomes orange with very long exposure. The change to orange indicates that the maximum possible action has taken place, and prints will not be strong and vigorous unless at least the deepest shadows show this orange colour when the print has been properly exposed. The image on the fully exposed print is comparatively feeble, but still can readily be seen, and its appearance serves as the guide to correct exposure. The recognition of correct exposure is perhaps the chief difficulty in platinum printing, but it is a difficulty that quickly disappears with a little careful practice. The point to learn is, which part of the negative should be just visible in the print before development. With Platona paper it is the lighter half-tones. In other words, the detail in the shadows and darker half-tones should be distinctly visible, and the detail in the weaker half-tones should be just faintly visible, but no detail should be visible in the high-lights—nothing beyond their general form and structure.

The exposed prints have next to be developed, and this may be done at once, or the prints may be kept for a day or two, provided that they are kept dry. The developer recommended is a solution of potassium oxalate and potassium phosphate.

PLATONA DEVELOPER: STOCK SOLUTION.

Potassium oxalate ...	2 oz., or	4 parts, or	72 grammes.
Potassium phosphate ...	½ " "	1 " "	18 grammes.
Water	14 " "	28 " "	500 c.c.

The solution may be made with hot water and allowed to cool; it can be kept for any length of time in bottles of ordinary glass, but should not be kept in lead glass bottles.

For use, part of the solution is diluted with an equal quantity of water.

If "hard" water is used for diluting the developer, a white precipitate will be produced. In districts where only hard water is available, it is best on the whole to take double the quantity of water specified (that is, 28 oz. or 1000 c.c., as the case may be), and filter the solution after the oxalate and phosphate have dissolved. The formation of the precipitate has no appreciable effect on the strength of the solution. It is obvious that the weaker developer thus made will not require diluting before use.

If any difficulty is experienced in getting potassium phosphate, ordinary sodium phosphate may be used instead, but the former is now generally obtainable from any good photographic dealer.

The developer is placed in a clean porcelain dish, and the exposed prints are floated on it face downwards, taking special care to avoid the formation of air-bubbles. The best plan is to hold the print by two opposite corners, so that it bends into a sort of paper arch with the exposed surface outwards, and then place it on the developer so that the middle of the print touches the liquid first, and the ends are gradually lowered until the whole surface is wetted. After a minute or two the print is carefully lifted and examined for air-bubbles; if any have been formed, they must be removed by means of a camel's-hair brush or the tip of the finger, and the print must be floated again on the developer. When the print no longer increases in intensity, development is complete.

Another method is to immerse the print in the developer face upwards. To do this the print is held by the corners of one of the longer sides, and the print is slipped steadily but quickly under the liquid. If any air-bubbles should form, they are removed as already described.

Development is carried out in weak daylight or in artificial light.

When removed from the developer ***the prints must not be put into plain water***, otherwise part of the iron salt will be precipitated in the paper, and will impart a yellowish tinge to the high-lights. The prints are lifted slowly out of the developer, so that they may drain as completely as possible, and are then treated with three successive clearing-baths of dilute hydrochloric acid.

Pure hydrochloric acid, conc.	1 oz., or	20 c.c.
Water	80 „ „	1600 „

A sufficient quantity of this dilute acid is placed in each of three porcelain dishes, which may conveniently be called Nos. 1, 2, and 3. The prints are placed in No. 1, and kept moving for five minutes; then transferred to No. 2 for another five minutes, and finally passed on to No. 3 for a third five minutes. Clearing-bath No. 3 must remain quite colourless, and as soon as it shows any tinge of yellow, bath No. 1 should be thrown away, the dish rinsed with water, filled with fresh dilute acid, and used as No. 3 bath, the originally No. 2 and No. 3 becoming No. 1 and No. 2 respectively.

After treatment with the third clearing-bath, the prints are washed in running water or in frequently changed water, with all the usual precautions, for fifteen or twenty minutes, and are then finished, and can be dried and mounted. They may safely be dried face downwards on clean blotting-paper, linen, or canvas, and if necessary the drying can be accelerated by heat. Mounting is comparatively easy, since the surface of the prints does not itself become adhesive, and the prints have very little tendency to curl or cockle.

It will be seen that the process is very simple, and occupies comparatively little time, all the operations of development, clearing, and washing being completed in little more than half an hour, whilst the prints can be dried with the aid of heat in a few minutes.

If the whites of the prints are not pure, but are greyish, the cause may be over-printing, or too much exposure to light during the manipulation, or the action of moisture on the paper before or during printing.

If the print is flat and lacking in contrast, the negative is probably flat, and all that can be done is to print in a weaker light, covering the printing-frame with tissue-paper if necessary, and taking care not to over-print.

Yellow or reddish-yellow stains are due to imperfect removal of the iron salts. The prints should be immersed for some time in a weak solution of oxalic acid, and then be well washed.

OTHER PRINTING PROCESSES.

The basis of the majority of the other photo-printing processes is the action of light on the salts of iron. The principal change is the conversion of a ferric salt, or persalt of iron, into a ferrous salt, or protosalt of iron, by the action of light in presence of organic matter such as paper; and the image formed consists of a ferrous salt which, by subsequent or simultaneous chemical changes, is converted into an image of Prussian blue (dark blue), ink (brown to black), metallic silver (red-brown to black), etc. In some processes the image is formed by means of the unaltered ferric salt, and in these cases a positive must be used to print from if a positive print is desired.

Blue Process or Cyanotype.—The paper is coated with a mixture of a ferric salt and potassium ferricyanide (red prussiate of potash), and must be kept in the dark in a dry place. When exposed behind a negative, or transparent positive, those parts which are subjected to the action of light become darker in colour, finally changing to a deep indigo. This is *not* the point at which to stop printing. If the action of light is allowed to continue, the dark parts gradually change to a reddish-lavender colour, indicating that the action is complete. All that remains to be done is to wash the print in several changes of water until the ground is quite white, the image being formed of Prussian blue. Warm, but not hot water may be used with advantage for washing.

If the ground of the print remains blue, either the negative is too thin or the paper has been kept too long.

This process is more especially applicable to such purposes as the reproduction of engineers' plans and tracings, but is often convenient for the purpose of getting a proof from any kind of negative with the minimum amount of trouble.

Direct sunlight should be used if possible, and the printing is then rapid, but in diffused light printing is comparatively very slow.

Colas' Process is now somewhat largely used for reproducing plans, tracings, etc. It differs from the iron processes previously described, in that it is the unaltered and not the altered iron salt that forms the image. The paper is coated with a ferric salt, or a mixture of such salts, and upon exposure to light the ferric salts, which give a black compound if brought into contact with gallic acid, are converted into ferrous salts, which give no such black compound. The paper must be carefully protected from exposure to light and from damp, and after exposure, which should be sufficient to make the exposed parts quite white, is immersed in a very weak solution of gallic acid. Since the image is formed by the ferric compounds on which the light has *not* acted, it follows that the process gives a negative from a negative and a positive from a positive. If the prints are grey where they should be white, exposure has been too short; if the image is weak, either the paper is old and has not been protected from light and damp, or the contrasts in the negative or transparent positive are not sufficiently great.

For details of these and other iron processes see "Ferric and Heliographic Processes," by G. E. Brown, published by Dawbarn & Ward.

Carbon Process or Autotype.—This process, based on the action of light on a mixture of potassium dichromate and gelatine, gives beautiful and permanent results, but is not easy to work. An explanation of all the necessary details of manipulation would fill a small volume, and those who wish to work the process are referred to the excellent "Autotype Manual" of the late J. R. Sawyer.

CHAPTER XV.

ENLARGEMENTS.

A PHOTOGRAPHIC enlargement is a negative or positive produced from a much smaller original. The power of making enlarged prints from small negatives effects a considerable saving in the cost of camera and lenses, etc., and is the most economical plan when large prints are only wanted from the best of the negatives, and a small number of prints is required from each negative. Moreover, to avoid the need of carrying a large camera and its appurtenances is a very great boon to travellers. Small cameras can be carried into many places where the bulk and weight of large cameras would be prohibitive.

Negatives from which enlargements are to be made should not have harsh contrasts, and must be full of variety in the half-tones, and of detail in the shadows. Comparatively small patches of clear glass in the negative become obtrusive patches of formless black in the enlargement. Negatives that give satisfactory prints of the original size do not always give satisfactory enlargements. Defective composition, want of variety in the half-tones or of form in the deeper shadows, that may pass unnoticed in the small print, not unfrequently become painfully apparent when magnified.

Two plans may be followed. An enlarged negative may be made from the original negative, and then any number of prints may be made by contact in the ordinary way; or if only a small number of prints is required, the enlarged print may be made on bromide or other paper, directly from the small negative. The apparatus required is practically the same in both cases, and will therefore be described first.

The source of the illumination employed for enlarging may be daylight or artificial light, and the optical arrangements usually adopted are different in the two cases.

One plan involves the possession of a room with a window (pointing preferably to the north) that can be blocked up or made opaque to photographically active light, with the exception of an area corresponding in shape and dimensions to the negative from which the enlargement is to be made.

Outside this aperture is fixed a reflector of corrugated mirror glass, opal pot metal, or white enamelled iron, which serves to reflect the light of the sky through the negative. The mirror, which is generally held in a wooden frame, may be permanently fixed at an angle of 45°, or may be attached at the bottom to hinges so that its inclination may be altered at will, the alteration being effected by means of a rod that is attached to one of the upper corners of the mirror and passes through a hole in the window frame into the room. The hole is, of course, packed so that no light can get through it. Plain mirror glass does not answer well as a reflector, since it reflects the images of clouds.

The negative is fixed against the aperture in any convenient way, and in front of the negative is a rectilinear lens, capable of working with a large aperture, by means of which the enlarged image is thrown on the paper or plate.

No light, except that which forms the image, must fall on the plate or paper, and hence some opaque material must stretch between the negative and the board supporting the lens. The simplest, and in many ways the most convenient plan, is to use an ordinary camera in the manner shown in fig. 38, putting the negative in the position usually occupied by the plate. The lens used should be of about the same focal length as that used for taking the original negative, and must of course have equally good covering power.

The paper or plate is supported on an upright board or easel, that can be moved along a base-board or tramway and so placed at any desired distance from the lens. The surface of the easel must be normal to the axis of the lens—*i.e.*, perpendicular to it in all directions, as shown in fig. 38 and in fig. 39.

Where circumstances make it difficult or impossible to adopt this plan, two cameras may be used (fig. 40), one small, with the negative to be enlarged from put into its dark slide, both shutters of which must be drawn, and the other large, its dark slide carrying the paper or the plate on which the enlarged image is to be formed. The lens of the small camera is inserted into the aperture usually occupied by the lens of the large camera, the opening being made light-tight by packing, if necessary. Exposure is made by

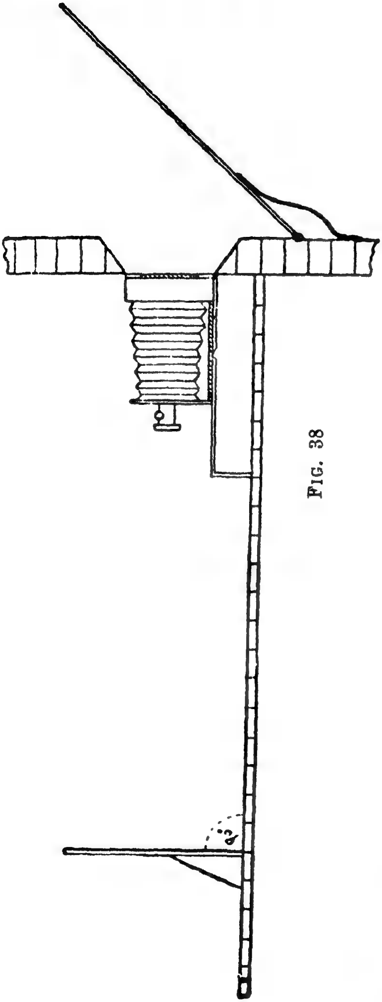

FIG. 38

tilting the base-board, to which both cameras are firmly attached, in such a way that the negative is pointed towards an evenly lighted sky. The shutter of the dark slide of the large camera is drawn, and then the negative is uncovered. When the exposure is finished, the negative is covered, and the large dark slide closed.

Artificial light can be used with the arrangement of two cameras. A sheet of ground glass or of *thin* opal glass is placed behind the negative in the small camera, in order to diffuse the light, and the lamp, lime-light, or electric light is placed behind that. In consequence of the lower photographic activity of artificial light as compared with daylight, this method necessitates somewhat long exposures.

When using artificial light it is advisable and customary to adopt some means of concentrating the light, and thus reducing the time of exposure. The apparatus then consists of four essential parts: (1) the illuminant

or radiant, (2) the condenser, (3) the objective, or lens forming the image, (4) the support for the paper or plate.

The radiant may be an oil lamp, such as is supplied with optical lanterns, or a good lamp with a cylindrical wick.

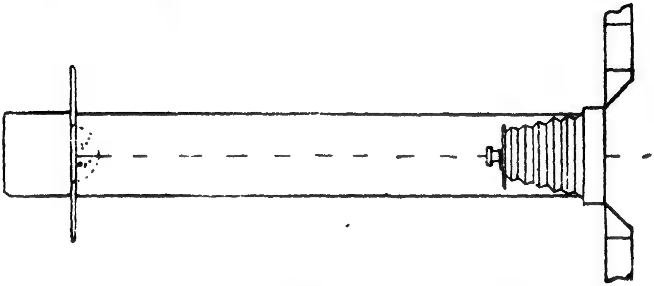

FIG. 39.

An Argand gas flame, or even an ordinary gas flame, may be used, but in these cases, as well as with the cylindrical oil flame, it is advisable to put in front of the radiant a piece of tin plate, with a circular or rectangular aperture as shown in fig. 41. The cutting off of some of the rays of course

FIG. 40.

increases the time of exposure required, but it improves the definition of the image.

The oxy-hydrogen or lime-light is much better than oil or gas, and if a blow-through jet is used is very easily manipulated after a little practice. Instructions will be found in any good book on the lantern.

The electric light (arc) is used in large establishments, but is out of the reach of the great majority of photographers.

The condenser is a lens, or combination of lenses, which collects the diverging rays from the radiant, and converts them into a converging beam, thus sending through the negative and into the lens a very much greater quantity of light than would be utilised if the condenser were not employed. The action of the condenser is illustrated in fig. 42. The converging beam must be a little greater in diameter than is necessary to illuminate the whole of the negative, and the whole of the beam that passes through the negative must pass into the front lens, or objective, whilst still converging, as shown in fig. 43, and not after it has begun to diverge again, as in fig. 44.

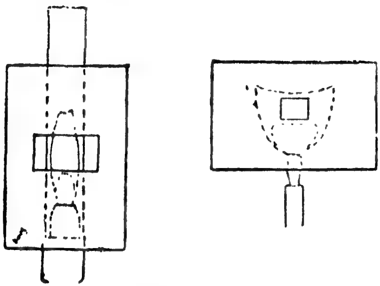

FIG. 41.

The size of the condenser required depends on the size of the negative that is to be enlarged from. In order that the whole of the negative may be properly illuminated, the diameter of the condenser must be a little greater than the *diagonal* of the plate. A quarter-plate negative requires a condenser $5\frac{1}{2}$ inches in diameter; a half-plate negative requires a condenser at least $8\frac{1}{2}$ inches in diameter. The condenser should be a little larger than is really necessary, but not too large, for in the latter case a large proportion of the light will pass outside the negative and be lost.

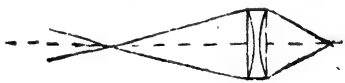

FIG. 42.

The lens should be a rapid rectilinear or a portrait lens, of about the same focus as that used for taking the negative, and of not less covering power. It should be worked with the largest aperture that will give sufficient definition.

The easel need only be a piece of perfectly flat board, provided

with struts or other supports for the purpose of keeping it quite perpendicular. Bromide paper is attached to the board by means of drawing pins. If the enlarged image is to be received on a plate, the easel must be provided with grooves, or small catches, to hold the plate. Focussing is done on a piece of white paper pinned to the board, or, when plates are used, on a piece of opal glass of the same thickness as the plate, placed temporarily in the position that the latter will

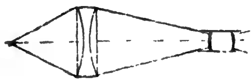

FIG. 43.

occupy. As when enlarging by daylight, the face of the easel must be exactly normal to the axis of the lenses (figs. 38, 39).

The proper positions of the lens and easel for an enlargement of a given size, from a negative of a given size, can be determined by trial; but it is usually much quicker to calculate these positions, which is easily done if the focal length of the front lens is known.

To determine the focal length of a lens with sufficient accuracy for this purpose, attach to the end of an ordinary rule a piece of white card (C, fig. 45). Place the lens on the rule with its

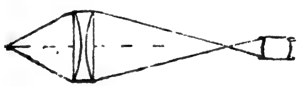

FIG. 44.

axis parallel with the rule, as shown in fig. 45. Now, keeping the lens in its proper position on the rule, point it towards the sun so that an image of the sun falls on the card. Move the lens backwards and forwards along the rule until the image of the sun is sharply defined. The distance between the diaphragm slot of the lens and the card may be taken as the focal length of the lens. (N.B.—Only the sun will serve for this purpose; a gas or other flame close at hand will not do.)

The focal length of the lens being known, the distance of

the easel from the lens is calculated by means of the following formula :—

$$d=(n+1)f$$

Where d is the distance of the easel from the lens, n is the number of times of enlargement, and f is the focal length of the lens. Suppose, for example, the focal length of the lens is 5 inches, and we wish to enlarge from quarter-plate to whole-plate, or, in other words, to two diameters : since quarter-plate is $4\frac{1}{4}$ inches long, and whole-plate is $8\frac{1}{2}$ inches long, then $n=2$ and $f=5$, so that

$$d=(2+1)\ 5$$

or $d=15$ inches. That is to say, the easel must be 15 inches from the lens. The distance between the negative and the

FIG. 45.

lens is found by dividing the distance between the easel and the lens by the number of times of enlargement ; in this case the distance is 15 inches, and the number of times of enlargement two, therefore $15 \div 2 = 7\frac{1}{2}$ inches.

Again, suppose the focal length of the lens is 12 inches, and we wish to enlarge from whole-plate ($8\frac{1}{2}$ by $6\frac{1}{2}$) to 26×20, or, three diameters. In this case $n=3$ and $f=12$, therefore

$$d=(3+1)\ 12$$

or $d=48$ inches. The easel must therefore be 4 feet from the lens, and the distance between the lens and the negative will be $48 \div 3 = 16$ inches.

The formula may be expressed in the form of a rule, as follows :—*To find the distance between the easel and the lens.*—Add 1 to the number of times or diameters of enlargement, and multiply the result by the focal length of the lens in inches : the product is the distance between the lens and the easel in inches. *To find the distance between the negative and the lens.*—Divide the distance between the lens and the easel by the number of times of enlargement. The formula or rule holds good both for daylight and artificial light.

The distances being ascertained in this way, the final focussing is done by moving the lens in the usual manner.

In order to secure good definition and freedom from distortion, attention must be paid to the adjustment of the condenser, objective, etc. It is of great importance that the apparatus should be properly centred, so that the axis of the front lens coincides with that of the condenser, and with that of the radiant, as shown in fig. 43. The relative position of the lens and the easel having been found by calculation, the final focussing must be done by moving the front lens. As a rule, to alter the size of the image you move the easel; to focus the image you move the front lens. The proper adjustment of the easel has already been explained.

Equality of illumination over the whole image depends on the proper centring of the radiant, and the proper adjustment of its distance from the condenser. Oil lamps usually slide in grooves and are centred by the maker, but Argand lamps, the lime-light, and the electric light have to be centred by the operator. With a sheet of white paper on the easel, and without any negative in the lantern, move the radiant up and down, to right and left, until the patch of light is in the centre of the easel. Remember that the rays are inverted by passing through the lenses, and therefore if you want the patch of light to move to the right you must move the radiant to the left, if you want it to move up, you must move the radiant down. If, when the light is centred, you have not a sharply defined and evenly illuminated disc on the easel, the radiant is not at the right distance from the condenser. If the circle is dark in the middle and bright at the edges, the radiant is too near the condenser; if the circle is bright in the middle and dark at the edges, the radiant is too far away. Move the radiant back or forward, taking care not to disturb the centring, until the disc is evenly illuminated. The radiant is now in its best position *for that particular position of the front lens*, but if you have to move the front lens for the purpose of getting a sharp image, you will also have to move the radiant in order to get the best effect with the front lens in its new position. The farther the front lens is from the condenser, the nearer must be the radiant, and *vice versâ*. The reason is that the nearer the radiant to the

condenser, the farther away does the cone of light come to a point, and *vice versâ* (see fig. 8).

Proceed in the following manner :—Having arranged the easel and the front lens at the proper distances from the condenser, centre the radiant and obtain an evenly illuminated disc in the manner already explained. Now put the negative into the lantern, and focus carefully by moving the front lens. Remove the negative and observe whether this disc is now evenly illuminated. If not, move the radiant back or forward, as the case may require, and then put back the negative, taking care not to alter the adjustments.

Now pin the bromide paper on the easel, in place of the white paper, or put a sensitive plate in place of the opal glass used for focussing on. Whilst this is being done an opaque cap is put on the front lens, and care is taken that no stray light escapes from any part of the lantern. If circumstances permit, it is best to turn down the radiant to a very low flame, or to extinguish it altogether. After the easel has been adjusted exactly to its former position, the radiant is turned up, the cap removed from the front lens, and the exposure made.

It is impossible to give any useful estimate of the time of exposure required; it depends on the character of the negative, the intensity of the radiant, and the degree of enlargement. Other things being equal, the time of exposure increases in the same proportion as the *area* of the image, or in proportion to *the square of the diameter* of the image. With the same radiant and the same negative, for example, an enlargement to whole-plate size ($8\frac{1}{2} \times 6\frac{1}{2}$ inches, or $55\frac{1}{4}$ square inches) would require only about one-quarter of the exposure necessary for an enlargement to 17×13 inches, or 221 square inches—*i.e.*, twice the diameter, or four times the area.

Work always, as far as possible, with a radiant of the same intensity, and classify your negatives according to their opacity as in ordinary bromide printing. It is a good plan at first to take a negative of a general character, and expose different parts of the paper or plate for different times, by covering up successive strips by means of an opaque card at the expiration of regular intervals of time, such as 30 seconds, 50 seconds,

70 seconds, and so on. On development it will be easy to see what time of exposure gives the best result.

When daylight is used the difficulty is still greater, because the photographic intensity of the daylight varies so enormously. Stanley's actinometer, which consists of a strip of bromide paper that darkens to a standard tint on exposure, will enable you to compare one day with another, the photographic activity being *inversely* proportional to the time required to bring the paper to the standard tint, whilst the exposure required is directly proportional to it. For instance, if one day it took twice as long to darken the actinometer paper to the standard as it did on another day, the exposures must be twice as long

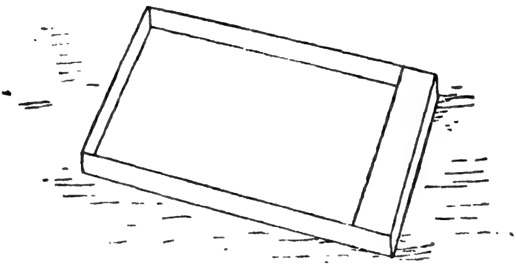

FIG. 46.

on the first day as they were on the second, all other conditions being supposed to be precisely the same on the two days. It is well to make experiments with two or three typical negatives, exposing different strips of the plate or paper for different lengths of time, an observation being made with the actinometer at the same time.

Development and all the subsequent operations are conducted in precisely the same way as when developing ordinary plates or bromide prints, except that the rapid bromide paper, which is generally used for making enlargements, may require a somewhat larger quantity of bromide to prevent chemical fog, and must not be exposed for any length of time to a *yellow* light.

The large dishes required for working the large sheets of

paper, or plates, may be porcelain, granitine, ebonite, papier mâché, wood with glass bottoms, or even tin well covered with Brunswick black or some good enamel. A great convenience when developing large sizes is a "well" dish. This is a dish covered in at one end, as shown in fig. 46, so that even when the dish is put up on end the liquid does not run out but collects in the "well" formed by the partial cover.* Examination of the print is thus facilitated, the developer can be poured off more rapidly, and if it is necesssary to add any further ingredient to the developer, this is done by simply running all the developer into the well by inclining the dish and there making the requisite admixture.

CHAPTER XVI.

MOUNTING AND FRAMING.

PRINTS may be kept loose in boxes, or may be put into albums in which they are simply held by the corners without being permanently fastened to the leaves. In this case they should be trimmed, and are often improved by stroking, the latter process getting rid of the wrinkles.

Stroking.—A piece of good American cloth is placed on the top of several smooth folds of flannel or some other soft material. The print is placed face downwards on the American cloth, and a hard flat ruler with a straight edge is passed over it. The print is held by one corner, and the ruler is scraped along the back of the print towards the opposite corner, considerable pressure being applied, and care being taken not to tear the print. It is important to see that the edges of the print are not turned up, or in any way torn, before beginning the stroking, for if there is anything in which the ruler can catch, the print will probably be torn across. The process is repeated from each corner of the print. Alpha, bromide, and gelatino-chloride papers show no great tendency to curl, but albumen prints very quickly curl up if left to themselves. The stroking process seems to remove this tendency almost

* It is important to observe that the dish must be of such a size that the plate or paper does not project into the well.

completely. Platinotypes, cyanotypes, and prints on plain paper generally do not require stroking.

Trimming.—This is most easily done by means of a specially made slab of glass, with flat edges, the corners being carefully ground to right angles, and the edges being quite straight. In the centre of the "cutting shape" there should be a handle for the purpose of holding it firmly down when in use. If no handle is attached, an empty cotton bobbin may be fastened to the glass by means of marine glue. In order to prevent the shape from slipping whilst in use, the under-side should be slightly ground, or may be covered with a thin layer of varnish which is allowed to dry without the aid of heat; but it must not be made so opaque that the print cannot easily be seen underneath.

The print is placed face upwards on a sheet of glass, preferably plate glass, the cutting shape is placed on it and held firmly down in the proper position, and the protruding parts of the print are cut off by means of a sharp knife that is passed round the edge of the cutting shape, care being taken to keep the blade of the knife flat against the edge of the glass. It is important to be certain that opposite edges of the print are parallel, and that adjacent edges are at right angles, or, in other words, that the print is properly cut square.

It is not necessary that every print should be of the maximum size that it is possible to get out of the negative, and there should be no hesitation about cutting the print down on one side or on all sides if its pictorial merit will thereby be increased. Many prints would be greatly improved from an artistic point of view by judicious lopping, such, for instance, as the cutting away of an uninteresting mass of foreground, or of sky. At the same time, care must be taken not to destroy the balance of the composition.

Mounts.—When a print has to be framed or exhibited, it should be mounted, and there is no question but that judicious mounting improves the appearance of a print. The prints may be attached to separate mounts, or may be mounted on the leaves of an album, that of Zaehnsdorff (which really consists of a number of separate mounts fastened together) having many advantages.

Considerable care should be taken in the selection of mounts,

and it should always be borne in mind that the proper function of a mount is to display the print and enhance its effect. The mount should always be subordinate, and should never vie with the print in attracting the observer's attention. Cream, brown, grey, and certain shades of grey-green are most generally suitable, but the colour of the mount is to some extent determined by the colour of the print. In some cases a deep olive green or a deep chocolate mount may be used with good effect. Mounting on a white card, with an "India tint" surrounding the print, if somewhat commonplace, is usually inoffensive. Plain sunk mounts are very effective with almost any class of subject; the print is mounted on a card, which is then fixed behind an aperture cut out of the mount proper.

The somewhat common practice of mounting a photo-print on a card previously or subsequently impressed with a plate mark cannot be recommended. A plate mark has a definite significance—namely, that the print which it surrounds has been produced from a metal plate in a press. Clearly, when a plate mark is put round a print that has not been produced in a press it is a sham, and is therefore bad Art.

Purity of the cards used for mounting is of the greatest importance, and the fading of the prints is often due to injurious substances contained in the mounts. Hypo. (sodium thiosulphate) is used to remove the chlorine employed in bleaching the pulp, and if any hypo. is left in the card, which is often the case, it is liable to attack the print.

To test for hypo. in mounts, allow some pieces to remain in contact with hot water for some time. Divide the solution into several parts: to one add some silver nitrate solution,—a white precipitate soon changing to brown indicates hypo.; to another add some scraps of zinc and some hydrochloric acid, and if the gas evolved has the odour of rotten eggs (sulphuretted hydrogen) hypo. is present*; to another add a few drops of a very dilute solution of potassium permanganate, and if the colour is discharged, some reducing substance, probably hypo., is present.

Bronze powder, which is sometimes used for marking names,

* Make sure that the zinc and the acid alone do not evolve this gas.

etc., on mounts, will cause an albumen print to fade wherever it comes in contact with it.

The mountant, or adhesive material, should be starch paste or gelatine solution, and the former is on the whole to be recommended. Rice starch is best.

The starch is mixed with a *small* quantity of water, and rubbed to a perfectly smooth cream by means of a spoon, and boiling water is then poured in, with continual stirring, until a transparent and somewhat thick paste is formed. It should be moderately stiff when cold, but not so stiff that it cannot be readily applied with a brush.

The position of the trimmed print on the mount having been determined, and marked by two pencil dots at the top corners of the mount, the print is placed face downwards on a clean piece of paper, and a *thin* coat of the starch paste is applied evenly to the back. The print is then carefully lowered into its proper position on the mount, a piece of clean white blotting paper is placed over it, and the print is pressed down and the excess of starch squeezed out by rubbing on the blotting paper with the ball of the thumb, working always from the centre of the print towards the corners. A sheet of strong smooth paper may then be placed over the blotting paper, and a straight-edge or ruler passed over it with considerable pressure in the same way as in stroking a print.

When placing the print on the mount it is essential that it should be equidistant from the sides, but it may be a little further from the bottom than from the top of the mount.

It is better to allow mounted prints to dry with free exposure to air. If the mounts show a tendency to curl, they may be straightened by *slowly* and *carefully* bending them in the opposite direction before the prints have quite dried. If the amount of curling is considerable, it is necessary to wet that part of the mount on which the print is to be placed (using a camel's hair brush); remove the excess of water by means of blotting paper after a minute or two, and then apply the mountant to the print and place it in position.

Rolling in a special press almost always improves the appearance of prints. The rolling presses are somewhat cumbrous and costly, and any one not producing a large number of prints will find it best to get his rolling done for him.

Burnishing consists in passing the print between hot rollers under considerable pressure, the print being lubricated by rubbing it with a piece of clean flannel moistened with a solution of pure soap in methylated alcohol. Care should be taken not to use too much soap: experience only can teach the right amount. Burnishing gives a somewhat high gloss to the prints, and as a rule is applied only to the smaller sizes, and more especially to portraits.

Glazed surface.—A very glossy surface can be given to prints by allowing them to dry in contact with some highly polished surface. For this purpose gelatino-chloride, bromide, or alpha prints are placed in a solution of alum after being fixed and washed, are afterwards thoroughly washed, and are then placed face downwards on a ferrotype plate or on a sheet of glass previously polished.* All air bubbles are removed and perfect contact ensured by stroking the back of the print with a squeegee, that is, a long and moderately stiff strip of indiarubber fixed into a strip of wood that serves as a handle. The prints are allowed to dry spontaneously, and as a rule the paper peels off as soon as it is perfectly dry; if not, a penknife is slipped under the edge at one corner, and, using the corner as a handle, the print is peeled slowly off the ferrotype or glass. Should it still show signs of sticking, the ferrotype or glass plate should be placed in front of the fire for some time. If the print will not come off under these conditions, it may be taken that the ferrotype or plate was not perfectly clean. It is of the utmost importance, however, not to attempt to strip until the print is quite dry. Risk of failure is reduced if the prints (after treatment with alum, and washing) are first allowed to dry, and are then again moistened with water and squeegeed on to the glass or metal.

If the glazed prints are to be mounted, the cards must be

* The glass is carefully cleaned and dried, and then some powdered talc, or "French chalk," is rubbed over it with a piece of clean flannel, and afterwards dusted off (not rubbed off) with another piece of flannel or with a flat camel's hair brush. Old negatives that have had the films cleaned off are not to be recommended for this purpose, since it is very difficult to get the glass sufficiently clean. Ferrotype plates do not require the treatment with French chalk unless they have been frequently used. Plates of enamelled metal have recently been introduced for this purpose.

attached whilst they are still on the glass or ferrotype, since if mounted afterwards in the ordinary way the surface would lose more or less of its brightness. When the back of the print is nearly dry it is brushed over with a very thin layer of starch or gelatine, taking care that none gets over the edge of the print and on to the glass, and the mount is pressed down upon it with the squeegee. When the whole is thoroughly dry (and this takes some time, because evaporation has to take place through the thick mount), a corner of the mount is lifted up with a penknife, and the mount is peeled off, bringing the print with it. Thin and somewhat porous cards are best for this purpose, and the prints are fixed behind sunk mounts. Of course, if they are mounted in any other way they must be trimmed before being put on the glass or ferrotype, and great care must be taken to get the mount in the proper position.

Matt surface.—The Ilford matt printing-out paper offers a ready and efficient means of obtaining prints which have an unglazed or matt surface, and which produce excellent artistic effects.

Spotting and working up.—Although a negative may have been retouched and otherwise doctored, it generally happens that still further improvements can be made by working on the print, preferably after mounting. Opaque spots, etc., in the negative cannot be removed without considerable risk, and they show of course as white spots, etc., in the print, and must be removed by the use of brush or pencil. Enlargements, especially portraits, as a rule require more working up than direct prints, for defects that are unimportant in small negatives are of course magnified in the enlargement. At the same time it must be remembered that it is difficult to work on a print without the brush or pencil work showing, and it is scarcely ever worth while to make a direct print from a negative that necessitates much more than spotting (*i.e.*, removal of white spots, etc.) on the print.

Gelatino-chloride, albumen, and alpha prints may be spotted or worked up with oil-colours or water-colours, but the latter must be mixed with some prepared ox-gall, which is readily obtained from any artist's colourman. If the ox-gall is not used it is difficult to get the colour to spread on the glazed

surface, and, moreover, if the spotting is done before the mounting, the colour is liable to wash out during the latter process. Gelatino-chloride and alpha prints should be treated with alum if they are to be spotted. Many workers prefer oil-colours to water-colours for this purpose.

It is obvious that the colours should be mixed so as to correspond exactly with the colour of the print, and care should be taken to use only such colours as are permanent when exposed to light.

Bromide prints are spotted with lead pencil or specially prepared crayon. They are worked up by means of specially prepared crayon, or ordinary crayon mixed with Chinese white, any high lights being put in with Chinese white. The colour of common crayon is too brown to match with the usual colour of bromide prints. When a considerable amount of surface has to be worked on it is best to use powdered charcoal and a stump. Platinotypes can usually be worked up with crayon, but if they are cold in colour it may be better to use a soft lead pencil.

It is obvious that anything beyond mere spotting requires a considerable amount of practice and some artistic knowledge and skill. Here, as with retouching, it is of great importance to avoid doing too much.

Framing.—A good or a bad frame improves or spoils the effect of a photograph almost as much as a good or a bad mount. Always bear in mind that the object of the frame is to set off the picture, and not to attract attention on its own account. The simpler the frame the better. A plain or beaded oak, with or without a narrow real gold flat under the glass, has almost always a good effect. Whether light oak or dark should be used will depend on the colour of the print and on the character of the subject, but if light oak is used it is better to leave out the gold flat. A reeded black frame, with or without a gold flat, is also effective, and for some subjects a reeded white frame may be used. Gilt frames are not to be recommended. The breadth of the wood and of the gilt flat, like the size of the mount, must be proportioned to the size and character of the print. If they are too large the print will be dwarfed and its effect minimised. Enlargements and large direct prints may often be framed without any mount,

there being only a gilt or narrow oak flat between the picture and the frame, or, in some cases, no flat at all.

Attention to the following maxims will conduce to the permanence of the prints:—(1) the glass should be pasted into the frame; (2) the mounted print must be thoroughly dry before being put into the frame; (3) the backboard must be quite dry; (4) the back of the frame should be carefully covered all over with a sheet of good paper, pasted down with frèsh paste, and allowed to dry thoroughly before being hung ,gainst a wall; (5) no frame should be hung against a damp wall; (6) if there is any danger from damp, put a sheet of Willesden paper between the mount and the backboard.

Mounting in Optical Contact with Glass.—This method may be said practically to combine mounting and framing. It is very effective, and is especially noticeable for the manner in which it increases the transparency of the shadows and brings out the details. The print is permanently fixed to a clean sheet of glass by means of gelatine, and the glass, which may be rectangular, oval, or circular, is fitted with a frame in the shape of a narrow brass rim, and a backing of stout paper, card, or thin wood.

The prints are fixed, thoroughly washed, treated with strong alum solution (unless they are on albumenised paper), again washed and dried. They are then trimmed so that they are slightly smaller than the glass to which they are to be fixed, and are placed in cold water, where they are allowed to remain for some time.

An ounce of moderately hard gelatine is allowed to remain for some time in 20 ozs. of water, until it has thoroughly swelled, and the water is then heated until the whole of the gelatine dissolves, the hot solution being strained through very fine muslin or well-washed calico into a clean porcelain dish an inch or two larger each way than the glass plates. This dish is placed inside another larger dish containing hot water, in order to keep the gelatine solution warm. Two or three of the glass plates, previously carefully cleaned, and made nearly as warm as the gelatine solution, are placed in the latter, care being taken that no air-bubbles remain attached to their surfaces. Now take one of the prints from the dish of water, allow it to drain, place it face downwards in the warm

gelatine solution, taking care that there are no air-bubbles on the under surface, and allow it to remain until it becomes thoroughly saturated with the gelatine. Then move the print into its proper position on the uppermost glass plate, and lift the plate, and the print with it, out of the gelatine, keeping the plate horizontal. With a squeegee sweep the excess of gelatine solution back into the dish, and press the print into close contact with the glass. Turn the plate over, and with the squeegee remove the excess of gelatine from the face of the glass. As soon as the gelatine has set, wipe it from the face of the glass with the aid of a sponge or cloth dipped in hot water, taking care that you do not disturb the print and that none of the water gets on to the back of it. Now put the plate in a rack or some other convenient position until it is thoroughly dry, when the metal rim and the back may be put on. The rims and backs can be obtained in various sizes and shapes. Glass plates can also be obtained with bevelled edges, and if these are used metal rims are unnecessary.

If the print is considerably smaller than the glass, and is carefully placed in the middle of it, the clear glass surrounding the print may be coated with opaque black varnish (applied on the same side as the print), which makes a very effective setting for many subjects.

CHAPTER XVII.

LANTERN SLIDES AND TRANSPARENCIES.

LANTERN slides and transparencies are positive prints that are intended to be examined by transmitted light, and they are made on plates coated with emulsion similar to that used for negatives, but, as a rule, finer in the grain and less sensitive. They can also be made with Alpha emulsion and with gelatino-chloride emulsion.

Lantern slides are transparencies of small size intended to be exhibited by means of the optical lantern. The size adopted in this country is $3\frac{1}{4} \times 3\frac{1}{4}$ inches, though quarter-plate size is also sometimes used with the longer dimension horizontal. The usual size in America is $4 \times 3\frac{1}{4}$ inches; the 4 inches

being the horizontal measurement. They are made by contact from negatives of the same size, or by reduction with the camera from negatives of larger size. A negative for lantern-slide making should possess much the same qualities as a negative used for enlarging. Excessive contrasts make the production of a good slide very difficult, and any notable amount of clear glass in a negative from which a slide is to be made by contact will give a slide showing too much deep shadow.

Making slides by contact.—The negative is put into a printing frame, carefully dusted, and a lantern-slide plate, also carefully dusted, is placed upon it in such a way that the two films are in contact. The back of the frame is then fastened down and the exposure made, artificial light being most commonly used. The general principles regulating the distance from the light, etc., are the same as in the case of bromide printing, and it is convenient to use the printing board shown in fig. 37. Special care must of course be taken that no light reaches the lantern-slide plate during exposure except that which passes through the negative. Printing frames of such a pattern that the ends of the negative (and consequently of the plate upon it) are not protected, are unsuitable for this purpose, and only those frames should be used in which the raised wooden edges at the back of the frame are continued across the ends, so as to enclose the negative on all sides.

Not unfrequently it is desired to make by contact a slide of part of a large negative. In this case care must be taken to place the lantern-slide plate exactly in the right position, and to see that its edges are parallel with the vertical and horizontal lines of the negative. Some care is necessary to avoid scratching the negative with the edges or corners of the lantern-slide plate, and to avoid moving the plate when fastening down the back of the frame. Special printing frames for making slides by contact from larger negatives can now be purchased, and are very convenient.

Making slides by reduction.—This process is the reverse of enlarging, and can be effected by means of the enlarging camera (fig. 40), the negative being placed in the large camera with the film inwards, and the lantern-slide plate in the plate-holder of the smaller camera. The camera is placed in such

a position that the negative is evenly illuminated, preferably by daylight, a sheet of finely ground glass being placed behind the negative if necessary. The author very rarely uses ground glass, and finds it sufficient to point the end of the camera carrying the negative towards an evenly illuminated tract of sky, away, of course, from the sun.

Another arrangement that can easily be constructed is shown in fig. 47. At one end of a baseboard of well-seasoned wood, not less than an inch thick, is fastened at right angles a smaller board, in the middle of which is an aperture of the same size as the negative from which the slide is to be made. The negative is supported in the aperture by grooves or catches, the film being towards the small camera. Two parallel strips of wood are fastened to the baseboard, and serve as guides for

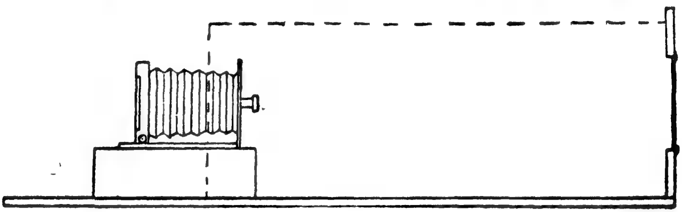

FIG. 47.

the block of wood to which the camera is fastened, the block being of such height that the lens of the camera is exactly opposite the middle of the negative, and of such width that it just slides easily between the guides. In order to protect the lens from any light except that which comes through the negative, a sort of rectangular tunnel of stout millboard stretches between the negative and the camera, in the manner indicated by the dotted line. The apparatus can then be used in an ordinary room, the baseboard being inclined or otherwise arranged so that the negative is presented to an evenly illuminated tract of sky. The lantern-slide plate is of course put into the dark-slide of the small camera. If the slide is made to hold quarter-plates, a strip of card, $3\frac{1}{4}$ inches long and $\frac{1}{2}$ inch broad, and of about the same thickness as the glass, must be put at each end of the lantern-slide plate to keep it in the middle of the dark-slide.

The distance between the lens and the negative depends on the size of the latter and the focal length of the lens. It is soon found by trial, but if required may be calculated by means of the formula previously given (p. 128), namely,—

$$d = (n + 1)f,$$

where d in this case is the distance between the negative and the lens, n the number of times of reduction, and f the focal length of the lens.

Suppose, for example, the focal length of the lens is 5 inches, the negative is 12×10 inches, and we want the picture on the lantern slide to be 3 inches long. Here the reduction is from 12 to 3 inches, or *four* times, therefore $n = 4$ and $f = 5$, so that $d = (4 + 1)\ 5$ or $d = 25$ inches.

To put the formula into words, *add one to the number of times of reduction and multiply the sum by the focal length of the lens in inches, the result will be the distance between the lens and the negative in inches.*

Focussing is done in the usual way, but special care must be taken, and a focussing glass may be used, for the image when exhibited will be greatly enlarged, and any want of definition will be very evident.

Daylight is much the best source of illumination for reduction, but artificial light such as the electric light, lime-light, magnesium, or even lamp-light, may be used. In such cases some plan must be adopted for diffusing the light so that the negative may be uniformly illuminated. Opal glass is an effective screen for this purpose, but it cuts off a large proportion of the light, and makes somewhat long exposures necessary.

Thin white paper is, on the whole, better, and any good *white* paper will do; but Rives photographic paper can be specially recommended. Another plan is to use two sheets of tissue paper at a distance of about an inch from one another; a sheet should be carefully stretched and fastened by means of paste or glue to each face of a wooden frame. Ground glass may also be employed, but generally two sheets with a space between them will be necessary in order to obtain uniform illumination.

Whichever kind of screen is selected, it is important not to put it in contact with the negative. There should be a distance of at least 3 or 4 inches between them, and care must, of course,

be taken that the screen is much larger than the negative, and that the latter is opposite to the middle of the screen.

When reducing by daylight, if the sky towards which the reducing camera is pointed is not uniformly illuminated, it is advisable to place a screen of ground glass or tissue paper behind the negative and at a distance of not less than 6 inches from it.

No useful estimate of the time of exposure can be given; it depends on the amount of reduction, the size of the stop, the character of the negative (more especially with regard to its opacity and freedom from colour), and the intensity of the daylight or other source of light. By working systematically in the manner recommended for enlargements (p. 130), using always the same plates, the same lens, and the same stop, classifying the negatives, and if necessary using an actinometer, it will soon become comparatively easy to estimate exposures correctly. Lantern-slide plates, being less sensitive, allow of greater latitude in exposures than negative plates.

Ilford Special Lantern Plates, giving black tones, may be used either for reduction in the camera or for contact printing. When printing by contact, the exposure to a No. 5 gas flame at a distance of 18 inches will be from 20 seconds upwards.

Development may be effected by means of quinol, and the developer used for negatives (p. 71 and 72) answers very well. A warmer colour and somewhat more transparent shadows are obtained if the developer is diluted with an equal bulk of water; development is somewhat slower and consequently is still more under control. When using quinol the development of these plates is so regular that there is considerable latitude in exposure, but at the same time the best results will only be obtained if the exposures are correctly estimated.

The ferrous oxalate developer (p. 106) may also be used, and gives black tones.

Excellent results are obtained by developing with ortol; the images are a beautiful warm black with very transparent shadows.

ORTOL SOLUTION.

Ortol	140 grains. . . .	15 grams.
Potassium Metabisulphite .	70 "	$7\frac{1}{2}$ "
Water, *up to*	20 ozs.	1000 cc.

SODA SOLUTION.

As for negatives, p. 61.

Mix equal quantities of ortol and soda solutions, and then dilute the mixture with from once to twice its own volume of water. The more dilute the developer the slower its action, and the warmer the colour of the resulting image. Several plates may be developed one after the other in the same quantity of developer, which becomes somewhat slow in its action, but may be strengthened by addition of some fresh developer when required. No clearing-bath is necessary, and the developed plates are rinsed with water and fixed in the usual way. This developer does not stain the fingers.

Great pains should be taken in judging the opacity. A slide that is too thin can be intensified, and one that is too opaque can be reduced by the Howard Farmer reducer.* Better results are obtained, as a rule, by reducing a slide that is too opaque than by intensifying one that is too thin; in the latter case there is a danger of losing the transparency in the shadows.

Alpha Lantern Plates are intended for printing by contact, and although they can be used for reductions in the camera, the exposures required are very long. The film on these plates is so thin, and its surface so smooth, that there may be some difficulty in ascertaining which is the coated side of the plate. It should be remembered that the plates are packed face to face so that the top plate is film down, the next film up, the next film down, and so on. As a last resource the *corner* of the plate may be touched with the slightly moistened finger, when the adherence to the gelatine, or non-adherence to the glass, is a sure guide.

Alpha Lantern Plates are coated with a sensitive emulsion of a mixture of haloid silver salts in gelatine, and are very much less sensitive than the special lantern plates. Their advantages are, ease in manipulation, certainty of result, and the range of colour possible in the finished slide.

The slides have to be toned, the operation being performed simultaneously with the fixing, and red, brown, sepia, purple, purple-black, and blue images can be obtained, according to the extent of the toning. Differences in colour also result from differences in the time of exposure and mode of development; but the colours obtained in this way are extremely uncertain, whilst those obtained by toning are easily under control.

* The ceric sulphate reducer (p. 80) is excellent for lantern slides.

Since the plates are comparatively insensitive, a large quantity of yellow light may be used during the manipulations, and indeed *must* be used during development, if the operation is to be properly watched.

Exposure may be made to daylight, but is much more under control if artificial light is used. The marked board used for bromide printing may also be used with advantage in printing on alpha plates. Instead of only one gas flame two may be used side by side, in order to shorten the exposure, or an Argand burner may be substituted for the flat flame burner. The exposure, as a rule, should be made at not more than 9 or 12 inches from the flame, and greater equality of illumination is secured if a sheet of opal glass is placed close to the burner, on the side opposite to the negative, in order that it may act as a reflector.

Somewhat thin negatives, with good gradations, give the best results, and the exposure required will be about a minute and a half, at a distance of 6 inches from a good No. 5 burner; but there is considerable latitude in the exposure.

Magnesium ribbon may be used instead of gaslight, and this course is to be recommended in the case of dense negatives. From 1 inch to 6 inches of the ribbon should be burnt, at a distance of 18 inches from the printing frame. With very opaque or stained negatives, the magnesium should be held nearer to the frame. If the negatives are classified into five or six groups according to their opacity, as recommended in the case of bromide printing, estimation of the necessary exposure soon becomes easy. When using magnesium two or three slides can be exposed at once, if the frames are put side by side.

Although the final colour of the slide is determined by toning, the colour of the developed but untoned image has considerable influence on the toning process. The maximum control over the final colour is obtained when the colour of the developed image is red or red brown, and this is the case only when full exposure has been given. The longer the exposure, in fact, the warmer the colour of the developed image; with a short exposure the image is olive-coloured, and it is difficult to obtain a satisfactory tone. A good red colour can only be secured when the developed and untoned image is red. It follows from these facts that a full exposure should always

be given, with proper care, of course, to prevent general fog.

Development is best effected with a dilute hydroquinone (quinol) and caustic soda developer.

No. 1.		No. 2.	
Hydroquinone . .	80 grains	Sodium hydrate (Caustic soda in sticks) . .	30 grains
Sodium sulphite . .	1 ounce	Potassium bromide .	15 ,,
Water . . .	*up* to 20 ounces	Water	20 ounces

For use take equal quantities of each.

The Hydroquinone Solution should not be used after it has become yellow, as it has then lost much of its developing power.

After development the plates are washed for a few minutes and are then ready for toning and fixing.

Toning and Fixing.—The two operations are most conveniently and satisfactorily done simultaneously, by means of a combined bath.

TONING AND FIXING BATH.

Hypo.	$2\frac{1}{2}$ ozs. .	25 parts.
Ammonium sulphocyanide .	$\frac{1}{4}$,, . .	$2\frac{1}{2}$,,
Stock gold solution* . .	4 ,, . .	40 ,,
Water, *up to*	10 ,, . .	100 ,,

Dissolve the hypo. and the other salt in 4 ozs. of hot water, allow to cool, add the gold solution, and make up to the final volume by the addition of more water. Filter if necessary. The gold solution must always be added *after* the other salts have been dissolved, or else some of the gold will be thrown out of solution.

The operation is conducted in weak daylight, or, better, by gas light. The well-washed slides are placed in the toning-bath a few at a time, and the dish kept moving. At first the image turns brownish yellow, and seems to be very much reduced, but it gradually regains its intensity and acquires a colder colour the longer it remains in the bath. The order of

* Stock gold solution used for toning bath of P.O.P.: 15 grains gold chloride in 15 ozs. water.

the colours is red, reddish-brown, warm brown, purple brown, purple, black, blue. Very long immersion in the bath is necessary in order to obtain the blue colour. Always bear in mind that *the dry slide will show rather more detail and density, and will have a somewhat colder colour than the wet slide.*

When the desired colour is reached, the slide is thoroughly washed, and then dried.

The original colour of the developed image affects the speed of toning and the colour that can be obtained. The shorter the exposure the longer is the time required for development, and the colder is the colour of the image before toning. With very short exposure the image will be greenish black, with more exposure olive green, and with longer and longer exposure cold brown, warm brown, red, and yellowish-red. A reddish brown or a red image is the most easily toned, and the exposure should be sufficient to give this colour on development.

If the dried slide is found to be insufficiently toned, it can be put back into the toning and fixing bath, either at once or at some future time, and the toning continued.

The only defects likely to be met with other than those arising from errors of exposure are: (1) dark stains arising from contact with traces of hypo., or the introduction of traces of hypo. into the developer; (2) discoloured patches, or patches of irregular density or colour, due to contact with dirt or greasy fingers.

A good lantern slide must have the very highest lights perfectly transparent, very little deep shadow indeed that is quite opaque, and all the rest of the subject in half-tones of infinite variety. The beauty of a slide depends on the clearness of the lights and the transparency of the shadows. Any muddiness in the shadows and half-tones, and any want of clearness in the highest lights, is fatal to the excellence of a slide.

Mounting.—The developed slide must be fitted with a mask to frame the picture, and with a cover glass to protect it from injury. Before attaching the mask it is advisable to varnish the slide with what is known as "positive" varnish. It must, of course, be perfectly colourless, and free from any solid particles.

Masks are cut from thin opaque paper, and may be had

either black on both sides, or black on one side and white on the other. The edges of the opening should be sharply cut and free from any raggedness. Masks with openings of various sizes and shapes can be purchased, and any special sizes required can be made to order. Carefully select a shape that suits the particular picture, and do not try always to have the picture the full size of the plate. Never hesitate to cut off part of the picture if the effect is thereby improved. In many cases it will be well to let the masked slide have the same proportions of length and breadth as the negative from which it was made, assuming that it was made by reduction.

Cover glasses are bought ready cut. They should be as thin as is consistent with reasonable strength, must be carefully cleaned, and free from scratches, striæ, and air-bubbles. The cover and the side are fastened together by means of a thin strip of well-gummed paper, sufficiently long to go all round the slide, and sufficiently broad to overlap the slide at both sides. The mask being adjusted, and fastened in its place with a touch of paste or gum, which is allowed to dry, the cover glass is placed on it, held firmly in position,* and the glasses placed on one end of the previously moistened binding strip, so that there is the same overlap at both sides. The strip is pressed tightly against the glass. The next edge of the slide is brought down on the strip, which is then pressed down. and so on until the binding strip is all round the slide. Some workers cut the strips up into pieces $3\frac{1}{4}$ inches long, using a short strip for each side of the slide, but it is not difficult to turn the strip in at the corners so that the binder is continuous all round the slide. Binding strips can be bought ready cut and gummed, but care is required in selecting them, as many are too thick and others are badly gummed. If a small quantity of treacle or glycerine is added to the water used for moistening the binders, there is less chance of the latter coming loose. Coloured binding strips are sometimes used, with a view to facilitate the sorting of slides belonging to different sets or different persons. Metal binding strips can also be obtained, but are more costly.

Slides should be marked in such a way as to indicate their proper position in the lantern. Place the slide on the table

* Small rotating clamps can be obtained for doing this.

so that the picture is right side up, and in its proper position as regards right and left. Now at each top corner put a small square, or round, patch of gummed white paper on the face of the slide. When the slide is put into the lantern carrier the white patches must be at the bottom and next the condenser. Instead of the two white patches, a white strip along the face of the slide does equally well. If one face of the mask is white, the title of the slide and other particulars may be written on it with ordinary or, better, Chinese ink. A white ink can also be obtained for writing on the black masks.

Clouds in Lantern Slides.—To have any considerable quantity of clear glass representing sky greatly detracts from the beauty of a lantern slide, and in order to obtain really good effects the introduction of clouds is necessary. It is very important, however, that the clouds should be in perfect harmony with the landscape as regards direction of lighting, etc., and that they should not be printed too deeply.

When the negative contains clouds, but the latter are too opaque to print under ordinary conditions, they may often be secured by masking or shading the landscape after it has been properly exposed, and continuing the exposure for the sky. If this plan does not succeed, careful application of the Howard Farmer reducer to the sky of the negative may make the clouds printable.

In other cases it will be necessary to supply clouds from another negative, and the simplest, and, on the whole most satisfactory plan, is to print the clouds on another lantern plate and use the latter as the cover-glass of the slide. Pay special attention to the harmony of the clouds and the landscape. Since the lantern-plate containing the landscape and that containing the clouds must be face to face when mounted *the clouds when printed, must be reversed as regards right and left.*

A proper cloud negative being selected, it is printed in the same way as the negative of the landscape; but the part where the landscape, etc., will come should be masked as far as possible. After fixing and washing, and whilst the film is still wet, the cloud slide should be placed in contact with the

landscape slide, back to back, and any part of the sky that would overlap the landscape must be removed by careful application of diluted Howard Farmer reducer with a brush. The sky slide is then finally washed, and when both slides are dry, they are bound together face to face, with a mask between, in the usual way.

In some cases a simple gradated sky may be used as described in the chapter on Positive Processes. It is obtained by exposing a lantern plate to artificial light in the same manner as the print is exposed to daylight.

Transparencies are made on lantern-slide plates by contact or enlargement, and may be any size. Development, etc., is effected in the same way as in the case of slides, but development must be carried considerably further, since a transparency must be more opaque than a slide. A piece of finely ground glass, or waxed paper, is placed behind the transparency, and a cover glass in front, the three being fastened together with a strip of paper or, better, metal, to which are attached rings or some other means of hanging the transparency against a window. If thought desirable, the transparency, with its backing and cover, may be permanently fastened into the window-pane.

CHAPTER XVIII.

PORTRAITS; OBJECTS IN MOTION; COPYING; PINHOLE PHOTOGRAPHY, ETC.

PORTRAITURE AND GROUPS.—Portraiture, if carried out extensively, necessitates the use of a properly constructed studio; and in any case, if the best results are desired, the lighting must be under the complete control of the operator. It is impossible here to enter into the details of studio practice, and the reader is referred to H. P. Robinson's "The Studio, and what to do in it." A good studio should be capable of being used from either end, and should be as simple as possible in construction and arrangement. There must be abundance of high side light, and all the light must be under control by means of blinds or hinged screens attached to the windows. Cross lights must be carefully avoided.

The exact mode of lighting the subject may be different in every case. The objects to be aimed at are: (1) to bring into prominence the most characteristic or attractive features, whilst avoiding harshness of contrast; (2) to secure roundness instead of a flat and diagrammatic effect; (3) to obtain breadth, as distinct from spottiness, and atmosphere, so that the figure stands out from the background.

Many photographic portraits are spoiled by insufficient exposure, the contrasts being too harsh, and the roundness and atmosphere being lost. Some are spoiled by spottiness in the lighting; others by excessive top-light; others again by the fact that the highest lights are not on the features, but on the shoulder, back, hands, or some article of dress, which consequently attracts the eye and distracts the attention from the face.

The background and accessories are very important factors in portraiture, and should always be as simple as possible; the face and figure are chief, and everything else should be subordinate. When head and shoulders or head and bust are photographed, a simple gradated background is as a rule the best, and a good effect is often secured by opposing the shadow side of the head to the lighter side of the background, and *vice versâ.*

Accessories should be few in number, unobtrusive, and in keeping with the costume and character of the subject.

The pose and arrangement of the figure should be simple and natural, the composition, etc., being in accord with the general principles laid down in Chapter IV.

Study carefully the face of every sitter before deciding on the mode of lighting, pose, etc. Both sides of a face are seldom alike. As a rule a three-quarter face is most pleasing, but in some cases a profile, in other a full face or very nearly full face, will give better results. If the camera is above the level of the head, so that the lens is pointing downwards, the forehead will seem broader, and the nostrils, mouth, and chin narrower, than if the camera were on the same level as the face; if, on the other hand, the camera is below the head, so that the lens points upwards, the chin, mouth, and nostrils will appear broader, the nose shorter, and the forehead lower and narrower.

The beginner is recommended to practise carefully with a life-size bust in plaster, terra cotta, or even wood, tinted or painted cream colour, or pale pink, in order that he may become thoroughly acquainted with the effects of different positions of subjects and camera, and different modes of lighting.

Get as much of the individuality of the sitter into the portrait as possible, and endeavour to secure the expression that seems to be most characteristic. An unnatural pose, or a strained position, is fatal to a good expression. Tact, discretion, and patience must be brought into play in order to put the sitter as much at ease as possible. It is in the highest degree desirable that he or she should not know when the exposure is being made, and this end is secured by using a *noiseless* shutter inside the camera. To use an ordinary lens cap, or a shutter outside the camera, when taking portraits, is deliberately to court failure.

Portraits at Home, or in ordinary rooms, are often very effective; the chief difficulties arise from the longer exposure required, in consequence of the lower intensity of the light, and the care that is necessary in order to avoid harshness of contrast in the lighting. It is seldom advisable to attempt more than single figure studies under these conditions. The

figure should be placed near a large window, and fig. 48 shows some of the possible arrangements of camera and subject, S_1, S_2, and S_3 being different positions of the subject, and C_1 and C_2 different positions of the camera. It is obvious that with the subject at S_2, or S_3, and the camera at C_2, the light side of the face will be the more prominent; whilst with the subject at S_1 or S_3, and the camera at C_1, the reverse will be the case. In order to obtain sufficient illumination of that side of the face which is away from the light, it will usually be found necessary to use a reflector in the shape of a white sheet, supported on a screen, clothes-horse, or in some similar way, this reflector being placed in the manner shown at A, A, fig. 48, or more in front of the subject if found desirable. The ordinary surroundings of the room may form the background, or a

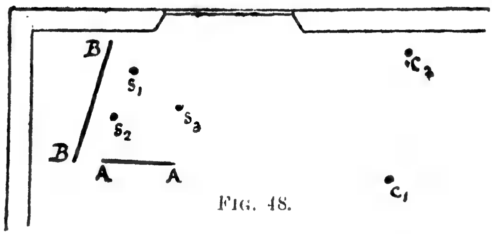

FIG. 48.

simple gradated background may be placed at B, B. In the former case, take care that no prominent lines of the picture frames, furniture, etc., pass directly behind the head or bust of the figure.

Portraits out of doors are more easily taken than portraits in ordinary rooms, and much shorter exposures are required, the drawback being that the lighting is much less under control. Select, as a rule, a position away from the sun, but with the light stronger on one side than the other. If an artificial background is not used, considerable care will be necessary, since many natural backgrounds are unsatisfactory. A hedge, or an ivy-covered wall, for example, unless in deep shadow, will have a spotty and unpleasant effect. Endeavour to have, if possible, nothing behind the head of the subject that in any way distracts attention from the features.

Small groups may be done in the studio or in very well

lighted rooms, but large groups can only be undertaken successfully out of doors. Great care is necessary in arranging the various figures, and the general principles laid down in Chapter IV. should be followed. The pyramidal form of composition usually gives the best effect, and with large groups a combination of several pyramids, *not all alike,* will be necessary. Avoid symmetry about the middle, and do not make both ends of the group alike either in size or arrangement. Avoid monotony in the pose of the individual figures, and take great care that the heads do not run in horizontal lines.

The lighting, especially in the case of large groups, should be from the front, but at the same time considerably towards one side, in order to avoid flatness. The camera must be pointed towards the middle of the group, and must be approximately equidistant from the two ends, or the figures will be disproportionate in size. There must be variety in the direction of the faces, but a good effect is obtained when the majority of the heads are turned towards the light, so that the shadow side of the face is the more prominent.

Take care not to under-expose, especially if your group includes figures in very light dresses. Further, if this should be the case, be careful about the distribution of the light dresses in the group, and remember that when using ordinary plates blue dresses, though moderately dark, will appear much lighter in the photograph.

Objects in Motion or Instantaneous Photography.—Moving objects require very short exposures, so that the blurring caused by the motion of the image during the time of exposure may be so small that it is not recognised by the eye. The term "instantaneous" photography is inaccurate, because all such exposures do occupy a certain time, and some of them are not particularly brief.

Work of this kind necessitates the possession of a lens, preferably rectilinear, that can be used with a large aperture, and a shutter by means of which the lens can be uncovered and covered in a very brief space of time. Rapid rectilinear or euroscopic lenses answer best, and for general purposes nothing is better than the Thornton-Pickard shutter already described, although where very rapid exposures are needed some special form of shutter must be used.

Since the exposures are so short, there is great danger that the shadows of the subject will be under-exposed, and it is only by using as large a lens aperture as is consistent with definition, and by working during the middle months of the year when the light is good, that the best results can be obtained. Since the short exposure tends to increase the contrasts, development requires considerable care, and it is advisable, in all cases where under exposure may be expected, to use a developer weak in pyro. whilst keeping the proportion of alkali at its ordinary amount, or to use the metol developer.

It should be a rule to give the longest exposure that the character of the subject and its rate of motion will permit. It is quite possible to lose pictorial effect by giving too short an exposure. Such a subject, for instance, as breaking waves, if photographed with a very short exposure, is unpleasing, because in the print the waves look as if cut out of stone, and all feeling of motion is lost. A much better effect is obtained by an exposure of one-tenth or one-fifteenth of a second, which gives an image that is not absolutely sharp and yet is sufficiently well defined to give no appearance of blurring.

Clearly, the more rapidly an object is moving the shorter must be the exposure, but it must be remembered that the blurring of the image will depend on the angular velocity, and not on the absolute velocity. For one and the same subject, with a particular rate of motion, the exposure must be shorter the nearer the object is to the lens. Further, for one and the same object, the angular velocity depends on the direction of its motion with respect to the lens; the angular velocity is greatest, and the exposure must be shortest, when the object is moving straight across the front of the lens; it is least, and the exposure may be longest, when the body is moving towards or away from the camera in the direction in which the lens is pointing. It follows that, if practicable, the object should be photographed more or less "end on," and that a "side on," view should be avoided.

When the moving object is under the control of the photographer he can, of course, select any point of view that he thinks best; in other cases he must choose the best point of view that he can, the lens being directed across the path of

the moving object. In either case it is necessary to know exactly when the image of the moving object is in the right position on the plate, for at this moment the exposure must be made. Some experienced workers find it sufficient to take a sight along the top corners, or along the side of the base-board of the camera, but the simplest and easiest plan is to attach to the camera a finder. This usually takes one of two forms: it may be a concave lens, which is attached to the top or side of the camera, and on the surface of which an image of the whole of the view that is projected on the plate can be seen in miniature; or it may be a small camera, the lens and ground glass of which are in the same relation to one another as the lens and ground glass of the camera proper, the ground glass of the finder being provided with a shade, so that the image formed on it can be seen without the use of a focussing cloth. In either case the finder is fixed to the camera, and adjusted in such a way that the image seen in it is identical with the image seen on the ground glass of the camera. The view point having been chosen, the image focussed, and the *shutter wound up and closed*, a dark slide is placed in the camera and its shutter withdrawn. The photographer then watches the image in the finder, having the ball of the pneumatic release for his shutter in his hand. As soon as he sees the moving object in the right place in the picture he releases the shutter.

Hand-cameras have lately become very popular, and, as the name implies, are used in the hand instead of being placed on a stand. They are very convenient when it is desired to take views in the streets of towns, where the setting up of a tripod would soon attract a crowd, or to photograph animals that would be frightened away by the tripod and focussing cloth. They are also indispensable when it is desired to photograph passing incidents, and to photograph people without their being aware of it. It should always be remembered, however, that to use a camera of this or any other kind in such a way as to give offence, or to be a source of annoyance, is (except when necessary for legal purposes) in the highest degree reprehensible. Most of the larger hand-cameras are so made that they can also be used as stand-cameras.

Exposures with a hand-camera must necessarily be brief,

because we have to avoid not only the blurring due to the motion of the object, but also any blurring that might arise from movement on the part of the holder of the camera. A good lens and very sensitive plates are essential. Ilford Monarch, or Special Rapid plates can be used when the light is not at its best, Ilford Empress when the light is good, and Ilford Ordinary when the light is very good.

The number of hand-cameras is so great that it is neither possible nor desirable to attempt to describe them. They may be broadly divided into four groups: (1) those in which the plates are contained in ordinary dark-slides; (2) those in which the plates or films are contained in a reservoir that is not detachable; (3) those in which the plate reservoir or magazine is detachable and can be replaced by another; (4) those in which a continuous film is used. Of these the first is sometimes inconvenient, especially when it is necessary to work without attracting attention. The devices adopted in groups (2) and (3) for removing the exposed plate and bringing a fresh plate into position are numerous; it is, of course, essential that the change should be effected rapidly and easily, without any risk of jamming. Other essential features in a good hand-camera are: (1) the lens must be rectilinear, work with large aperture, and have good covering power and depth of focus; (2) the shutter must be rapid, capable of adjustment in speed, work without jar, be easy to release, and be reset without any necessity for capping the lens; (3) there should be means of focussing for objects at different distances; (4) there should be two finders—one for use when the long edge of the plate is horizontal, and the other for use when it is vertical; (5) there should be means of attaching the camera to a stand and giving long exposures when the nature of the subject makes this desirable. It is an advantage to have spirit levels attached to the camera, but these are not indispensable when the finders are properly set.

When the instrument is used, a careful estimate must be made of the distance of the principal object (which is easily done after a little practice), and the lens must be set for this distance. Care must be taken that the subject and its surroundings appear in their proper positions in the finder, and when releasing the shutter it is important to avoid moving

the camera. When architecture or any other object with vertical lines is included in the picture, it is essential to keep the camera perfectly level, and this course must be adopted with every class of subject if it is desired to avoid distortion. Every one must find by experience which method of holding a hand-camera suits him best, but under the right arm, with the case held against the side of the body, is the position most generally adopted.

Considerable care is required in the development of plates exposed in hand cameras, precautions against harsh contrasts being especially necessary when very short exposures have been given.

Copying, etc.—Copying plans, engravings, pictures, etc., requires certain special precautions. The lens must point directly at the centre of the object to be copied, and the latter must be normal to the axis of the lens, precisely as explained in the case of enlargements (p. 124 and figs. 38 and 39). When it is necessary that the dimensions of the photograph should have a definite relation to the dimensions of the original, the formula on p. 145 must be used for reduction, and the formula on p. 130 for enlargements. If an object is to be photographed exactly its real size, the distance of the object from the lens, and the distance of the ground glass from the lens, must both be twice the focal length of the lens. Great care must be taken to secure even illumination, and the direction of the light must be such as to make the grain of the paper as little visible as possible. Paintings must be lighted from the same side as they were when painted, which is usually the left side. These subjects present special difficulties in consequence of the failure of ordinary plates to render the colours properly, and orthochromatic plates must be used in accordance with the principles laid down in the next chapter. Photographic prints should be glazed, if possible, in the manner described on p. 138, as this gets rid of the grain of the paper and improves the rendering of the shadows. When drawings, engravings, and other line subjects have to be copied, it is necessary to keep the lines perfectly clear in the negative, and this is difficult with almost any gelatine plates.

The Ilford Process Plates are the best to use for this purpose, and the pyro.-soda formula given on p. 61 answers very well,

though with line subjects it is advisable to double the proportion of bromide. Good results can also be obtained on the Ilford Ordinary plates, if care be taken not to over-expose; but with these plates it will be found necessary, as a rule, not only to increase the proportion of bromide, but also to mix 2 parts of pyro. solution with only 1 part of sodium-carbonate solution.

It is important, when dealing with line subjects, not to stop development too soon; and it should be remembered that, although an increased proportion of bromide lessens the tendency to fog or to clog up the lines, it materially lengthens the time required for development.

Another point of great importance, when clear lines are required, is to prevent the entrance of any stray light into the lens. No direct light must fall into the lens, and it is useful to attach a cone of blackened cardboard to the front of the lens. The lens barrel, the edges of the stop, and the inside of the camera must be dead black.

Scientific Specimens, etc.—Fossils, ancient implements and pottery, apparatus and specimens of all kinds have frequently to be photographed, and present no special difficulties except that of obtaining the lighting that is best suited to bring out the characteristics of the particular object. Frequently it will be found best to take three views: (1) left side, (2) right side, (3) front view; using, if necessary, a different mode of lighting in each case. The value of the prints is greatly increased if the distance of the object, the focal length of the lens, and the exact direction of the lens are given in each case, or, better, if a graduated scale is placed close to and in the same plane as the specimens, and is photographed with them. Negatives of this kind ought never to be retouched in the slightest degree.

Pinhole Photography.—It is well known that when the rays of light reflected from an object are allowed to pass through a minute aperture in a chamber or box, an image of the object is formed on the side of the chamber or box opposite the aperture. This image will, of course, act on a sensitive film, and can be photographed in the same way as an image formed by a lens; but since the apertures required for the

formation of a sufficiently well-defined image are very much smaller than the smallest aperture that it is customary to use with a lens, very much longer exposures are required.

The images formed by pinholes lack the sharp definition characteristic of the images formed by good lenses, and the softness of effect resulting from the absence of fine definition is regarded by some photographers as a great gain in the direction of pictorial value.

The image formed is mathematically correct, and hence pinhole photographs may be of great service in topographical surveys, for the calculation of heights, distances, etc. The size of the image depends on (1) the size of the object, (2) the distance of the object from the pinhole, and (3) the distance of the plate from the pinhole; it is directly proportional to (1), inversely proportional to (2), and directly proportional to (3). If we know three of the magnitudes we can calculate the fourth. For instance, to find the size of an object, its distance being known, multiply the size of the image by the distance of the object from the pinhole, and divide by the distance of the plate from the pinhole. To find the distance of an object, its real size being known, divide the size of the object by the size of the image, and multiply by the distance of the plate from the pinhole.

The angle of view depends on the size of the plate, and the distance of the plate from the pinhole. For pictorial purposes the angle should not exceed 45°, but for topographical and other purposes it may be greater, and may even be as high as 100°. The enormous angle of view that can be included when a pinhole is used makes this method very valuable when it is desired to secure photographs of architectural subjects in unusually cramped situations. The angle of view included with a plate of any particular size, at a particular distance from the pinhole, may be obtained from the table on p. 183, the distance between the pinhole and the plate being substituted for the focal length of the lens. To perform the reverse operation, and find the distance from pinhole to plate necessary in order to obtain a particular angle of view, look out the quotient corresponding to that angle, divide the base of the plate by the quotient, and the result will be the necessary distance.

All the apparatus that is really necessary is a light-tight box, with some means of holding the plate in position at one end, whilst the pinhole is in the centre of the opposite end. The pinhole, or aperture, should be pierced in a thin sheet of metal, and must be perfectly smooth and round. An ordinary camera and dark slides may of course be used, and plates of metal can now be obtained which fit in the place of the lens, and are pierced with apertures of different dimensions, and provided with a shutter. These plates are a great convenience when this kind of work is being done.

For every particular distance of the plate from the pinhole, there is one particular diameter of pinhole that will give the best photographic definition, a wider or narrower hole giving worse definition; and, according to Abney, this can be calculated by means of the approximate formula—

$$P = 0{\cdot}008\sqrt{d},$$

where P is the diameter of the pinhole in fractions of an inch, and d is the distance between the pinhole and the plate. To put the formula into words, multiply 0·008 by the square root of the distance between the plate and the pinhole (in inches), and the result is the best diameter of the pinhole in fractions of an inch. It makes very little difference if the pinhole is a little larger or a little smaller than the calculated diameter.

Maskell recommends the following diameters of pinholes, and distances of the pinhole from the plate, with plates of the ordinary photographic sizes. The dimensions are all in inches, and the diameters of the holes do not differ materially from those calculated by means of Abney's formula. The angle of view is about 28° :—

Size of Plate.	Distance of Pinhole.	Diameter of Pinhole.
$4\frac{1}{4} \times 3\frac{1}{4}$	9	$\frac{1}{40}$
$6\frac{1}{2} \times 4\frac{3}{4}$	13	$\frac{1}{40}$
$8\frac{1}{2} \times 6\frac{1}{2}$	16	$\frac{1}{30}$
10×8	20	$\frac{1}{25}$
15×12	30	$\frac{1}{25}$
Larger	36	$\frac{1}{20}$

For an angle of view of about 45° the following distances and dimensions of pinholes have been calculated :—

Size of Plate.	Distance of Pinhole.	Diameter of Pinhole.
$4\frac{1}{4} \times 3\frac{1}{4}$	5	$\frac{1}{50}$
$6\frac{1}{2} \times 4\frac{3}{4}$	8	$\frac{1}{45}$
$8\frac{1}{2} \times 6\frac{1}{2}$	10	$\frac{1}{40}$
10×8	12	$\frac{1}{35}$
15×12	18	$\frac{1}{30}$

The time of exposure required is of course subject to the same external conditions of intensity of light, character of subject, etc., as in the case of a lens. It is independent of the size of plate used, and, other conditions remaining the same, depends on the size of the pinhole and its distance from the plate. The exposure required varies inversely as the square of the diameter of the pinhole, and directly as the square of the distance of the pinhole from the plate. The relative approximate exposures for pinholes of the most useful diameters are as follows :—

Diameter, in inches	$\frac{1}{25}$	$\frac{1}{30}$	$\frac{1}{40}$	$\frac{1}{50}$
Relative exposure	1	$1\frac{1}{2}$	$2\frac{1}{2}$	4

whilst the approximate relative exposures required for different distances are as follows :—

Distance, in inches	5	8	10	12	15	18	20	25	30
Relative exposure	1	$2\frac{1}{2}$	4	$5\frac{3}{4}$	9	13	16	25	36

As a rough guide it may be stated that a brightly lighted landscape will require, with a pinhole $\frac{1}{45}$ in. diameter, at a distance of 8 inches, about five minutes; with a pinhole $\frac{1}{40}$ in. diameter, at a distance of 10 inches, about six minutes; with a pinhole $\frac{1}{25}$ in. diameter, at a distance of 20 inches, from ten to twelve minutes.

When working with a pinhole it is necessary that the camera should be level and the plate perpendicular. There is no focussing; but it is necessary to know that the desired picture is on the plate, and this is done either by using at first a sufficiently large aperture to give a visible image, a smaller one being substituted for it before making the exposure, or by using a view finder, which must be adjusted for the size of plate and distance of pinhole that is being used.

Since the exposures are long, motion of trees, etc., is of little importance, provided that they return to the same mean position, but anything that is permanently displaced will either not be photographed at all or will show a blurred or multiplied image. People, for instance, passing along a thoroughfare, or continually moving about a room, leave no impression on the plate.

CHAPTER XIX.

ORTHOCHROMATIC OR ISOCHROMATIC PHOTOGRAPHY.

VERY little experience is sufficient to teach a photographer that ordinary photographic prints do not represent coloured objects with their proper degrees of relative brightness. Certain colours, such as green, yellow, and orange, that are bright to the eye, are represented as dark in the photographic print, whilst, on the other hand, blue and violet, that are dark to the eye, are light in the print. The relative sensitiveness to rays producing different colour sensations is almost exactly reversed in the case of the human eye and the photographic plate. This is represented by the curves 1 and 2 in fig. 49, which represent the relative action of different parts of the spectrum. The base line in each case represents the spectrum; the vertical lines, distinguished by the letters of the alphabet, represent certain prominent dark lines which are seen in fixed positions in the spectrum of sunlight, and which serve as reference lines for any spectrum, A is at the extreme end of the red, B in the red, C in the orange-red, D in the yellow, E in the bluish green, F at the beginning of the blue, G between the blue and violet, and H at the extreme end of the visible violet, L, M, and N being in the invisible part of the spectrum. The height of the curve above the base at any point indicates the amount of action at that point, and it will be seen that in the case of the eye the greatest effect is exerted by the yellow, about half as much by the orange and green, much less by the red and blue, and still less by the violet and extreme red; in the case of the ordinary plate, on the other hand, blue exerts

the greatest effect, violet a considerable effect, green a small effect, and yellow, orange, and red no effect at all unless the exposure be long. Here we have the explanation of such facts as that an orange dress appears very much like black in a photograph, whilst a blue dress appears very much like white, and also that we can use orange and red light when manipulating our plates.

It is clear that if our plates are to represent coloured objects properly (*i.e.*, with the degrees of relative brightness that they seem to the eye to possess), we must in some way greatly increase the sensitiveness of the plates to red, orange, and yellow, whilst at the same time reducing the sensitiveness to blue and violet. The first of these ends can be attained by intimately associating the sensitive emulsion with certain colouring matters, more especially those known as the eosins and cyanin. They are termed *optical sensitisers*, or, much better, *selective sensitisers*. This is done in two ways; by immersing the prepared plates in a very dilute solution of the colouring matter, with or without ammonia, or by adding the dye to the emulsion in the process of manufacture. The first method, if an ammoniacal bath is used, gives the highest degree of sensitiveness, but the plates will only keep for a short time. Plates prepared by adding the colouring matter to the emulsion, or during emulsification, have much better keeping qualities.

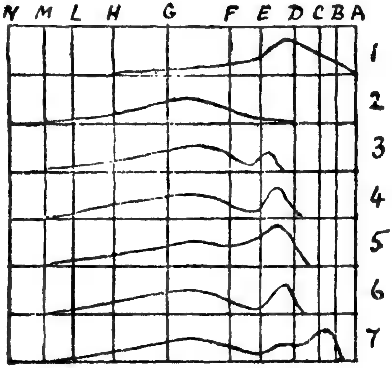

FIG. 49.

1, Eye ; 2, Ordinary plate ; 3, Plate with ammoniacal eosin ; 4, Plate with aqueous erythrosin ; 5, Plate with ammoniacal erythrosin ; 6, Plate with ammoniacal Rose Bengal ; 7, Plate with ammoniacal cyanin.

Photography carried out by means of plates prepared in this way is termed orthochromatic, isochromatic, colour-sensi-

tive, or colour-correct photography. The first and third terms are preferable and are most largely used. The plates are spoken of as orthochromatic, isochromatic, or colour-sensitive plates.

Ilford Chromatic Plates are sensitised in the emulsion.

When ordinary white light is predominant, the relative exposures required by the six brands of Ilford negative plates are as follows, the Chromatic being exposed without any screen :—

Monarch.	Special Rapid.	Empress.	Ordinary.	Chromatic.	Process.
-	-	-	-	-	-

When the subject reflects a large proportion of green and yellow rays, and when the light is hazy or yellowish, the relative rapidities of the chromatic plates are considerably higher.

The chromatic plates require more careful handling than the ordinary plates, and must be developed with the pyro.-soda developer (see p. 61) ; pyro.-ammonia cannot be used without great risk of fog.

Ilford Ordinary plates and Ilford Empress give very good results by the bath method. Erythrosin (the sodium or potassium salt of tetra-iodo-fluorescein) is the only selective sensitiser that gives useful results without ammonia. The following solution is made up :—

Erythrosin solution (1 in 1000)	1 part.
Water	9 parts.

The plates are dusted and laid in this solution for two or three minutes, with occasional rocking, the operation being conducted in a dim ruby light. They are then allowed to drain, are placed with their lower edges on clean blotting paper for a few seconds, and are dried in complete darkness in a pure atmosphere. This bath gives a degree of sensitiveness quite sufficient for copying pictures, photographing flowers, etc., and for micro-photography, where short exposures are not necessary.

When an ammoniacal bath is needed the following formula is good :—

Dye stock solution (1 in 1000)	1 part.
Ammonia solution (1 in 10)	1 ,,
Water	8 parts.

Dust the plate, immerse for two minutes, allow to drain, place the lower edge on blotting paper for a few seconds to remove the ridge of liquid that collects there, and dry in complete darkness in a pure atmosphere. Use as soon as possible after preparation and develop with pyro.-soda in preference to pyro.-ammonia.

The sensitisers that give the best results are cyanin (which must be kept dissolved in alcohol), erythrosin, and Rose Bengal. In connection with the two latter it may be mentioned that the use of eosin dyes with an alkali was the subject of Patent 101, 1883. Cyanin was not included in the patent, and is very liable to give fog, but is at present the only useful sensitiser for orange-red and red.

The stock solutions of the sensitisers contain one part of the dye in 1000 parts of solution. They should be made with distilled water (or in the case of cyanin, with absolute and not methylated alcohol) and must be kept in the dark.

In whichever way the plates are sensitised, all manipulations must be conducted in ruby light, and as little of it as possible. Special care is necessary in the case of cyanin, and in this case the best screen for the developing lamp is several sheets of brown (not red-brown) tissue paper.

The advantage of orthochromatic photography is most evident in copying paintings, photographing flowers and similar subjects, and in photographing objects under the microscope. For these purposes orthochromatic plates are now regarded as indispensable. In dull weather, especially when the light is yellowish, as in autumn and winter, the sensitiveness of the orthochromatic plates to yellow and orange gives them considerable advantage over ordinary plates in the studio and out of doors, and enables shorter exposures to be given.

For general outdoor work their advantage is less marked,

although it becomes very evident at certain times of the year and under certain conditions. The author's own experiments lead him to the conclusion that orthochromatic plates, when used with a proper screen, always have an advantage over ordinary plates, though the advantage is considerably smaller at some times than at others.

In portraiture the advantage of orthochromatic plates lies in the better rendering, not only of the colours of dresses, etc., but also of the flesh tints and hair. Freckles and other irregularities of the complexion become less prominent, and considerably less retouching is necessary.

The use of screens is at present a very important part of orthochromatic photography. Although the use of selective sensitisers produces great sensitiveness to green, yellow and orange, it does not greatly reduce the sensitiveness to blue and violet. The result is that blue and violet objects still appear too light in the photographs. This difficulty is got over by interposing in front of the lens, between the lenses, or behind the lens, a transparent yellow screen, which cuts off a certain proportion of the blue and violet rays, and thus compensates for the excessive sensitiveness of the plates to these rays.

In many cases a very considerable improvement can be observed without the use of any screen at all, especially in the case of such subjects as flowers, but to obtain a reproduction that will satisfy critical examination under eyes trained to properly appreciate the monochromatic rendering of coloured objects the use of a screen is necessary. *Great care is required in selecting the screen, for if too much blue and violet is cut off these colours will appear too dark, and the photograph will then be wrong in the opposite direction.* For general purposes a lemon-yellow screen, not too dark, answers best, but in dealing with difficult subjects such as paintings, or any subjects containing much red, deeper screens are necessary. Where red is present in considerable quantity an orange screen may be used, and a considerable exposure given, in order to obtain the reds; a yellow screen is then substituted for the orange, and a shorter exposure given for the other colours. The proper selection of screens places great power in the hands of the photographer.

In landscape work the author uses a lemon-yellow screen.

The advantage is greatest in spring and autumn, much less in full summer, and least in winter. When the light is yellow (for example, towards sunset), orthochromatic plates will show a distinct difference from ordinary plates even without a screen; but in other cases the advantage is, as a rule, not recognisable unless the screen is used. The employment of the screen, however, is a simple matter, and gives no more trouble than the use of an ordinary stop.

The author prefers to attach his screen to the stops, and uses a film of collodion * stained with aurantia (*not* aurine), but this method is not practicable when an iris diaphragm is used. Coloured glass may be used, but must be optically worked; a good plan is to have a disc which slips into the hood in front of the lens and is kept in its place by a brass ring. When several lenses are used it is the most convenient to have one screen that will serve for all of them. In this case a piece of optically worked glass answers best, and may be used before, or, better, behind the lens. The Ilford Company supply two screens, one considerably darker in colour than the other. They are made in different sizes, and are best used behind the lens in conjunction with a holder (supplied with them), which keeps the glass close up to the lens whatever may be the projection of the latter through the flange.

With the Ilford chromatic plates, the lighter screen necessitates three times the exposure, and the darker screen six times the exposure that would be required if no screen were used.

* In order to prepare these screens, a strong alcoholic solution of aurantia is added to enamel collodion until the latter has a deep orange colour. A piece of plate or patent plate glass is thoroughly cleaned, and rubbed with powdered French chalk, which is then dusted off with a camel's hair brush or a piece of perfectly clean flannel. The prepared glass is then coated with the dyed collodion, the thickness of the film being made greater the greater the depth of tint required in the screen. The depth of tint of the finished film depends on the amount of aurantia added to the collodion, and on the thickness of the layer of collodion that is spread on the glass plate; and it is very easy to prepare films giving a great variety of depth of tint. The film is allowed to dry perfectly in a place free from dust, and then, if a penknife is run round the edges, the collodion may be *slowly* stripped off the glass. The stripped film is cut up, and can be kept flat between sheets of note paper. It is attached to the stops by means of gum or paste (a thin film of which is rubbed on the stop), and must be perfectly flat.

When photographing microscopic objects, the character of the screens used will be determined by the nature of the stains used in the preparation of the object, and the degree of prominence that it is desired to give to different details of its structure.

To carry out orthochromatic photography successfully requires care and thought, with some grasp of the principles involved, and a considerable knowledge of colour and its rendering in monochrome. Of the advantages of this newer method no one who makes a few careful experiments will have any doubt.

CHAPTER XX.

PHOTOGRAPHY BY ARTIFICIAL LIGHT.

ARTIFICIAL light is, as a rule, so poor in photographically active rays, that its use in photography is confined to copying and other purposes which admit of long exposures being given. This objection does not hold, however, in the case of the light evolved by the combustion of magnesium (which is relatively richer in chemically active rays than even sunlight), certain other forms of light obtained by chemical methods, and that form of the electric light which is known as the arc light. The incandescent electric light, on the other hand, from a photographic point of view, is on the same footing as gas light or lamp light.

Electric light.—For information as to the construction and use of the various forms of arc light, the generation and regulation of the electric current, etc., reference must be made to books on technical electricity. The chief difficulty when using the light for photographic portraiture arises from the fact that, instead of being apparently diffuse* like even direct sunlight, the rays proceed from a very small though intense radiant, which is necessarily close at hand. As a consequence, great care and special arrangements are needed, in order to avoid

* The real explanation is that the rays of sunlight are practically parallel, whilst those from the electric arc are divergent, any particular cone of rays including a somewhat wide angle.

harsh contrasts in the lighting and sharp definition of the shadows. The most successful plan is to place close to the lamp, and between it and the sitter, a small semi-transparent screen of ground glass or similar material, which diffuses the light, whilst behind the lamp is a large reflector which directs the light on to the subject. It is usually necessary to have reflecting screens on the far side of the sitter, in order to avoid very deep shadows. It is easy to make the lamp and reflector movable, so that the direction of the light is perfectly under the control of the photographer.

Magnesium light.—Metallic magnesium may be burnt in two ways: (1) slowly, in the form of ribbon, or (2) rapidly, in the form of powder, either by means of the air or by mixing it with some substance rich in oxygen.

The ribbon is best burnt with the aid of a lamp provided with clockwork that keeps up a continuous supply of ribbon at a speed that can easily be regulated. Burnt in this or a similar way, magnesium was used comparatively early in the history of photography, for photographing caves, the interior of the pyramids, etc., its portability and the great activity of the light produced by its combustion making it especially valuable for purposes like this. Combustion in this manner is, however, comparatively slow, and the exposures are consequently long—too long, in fact, for portraiture or similar purposes. By using the magnesium in the form of powder much greater rapidity of combustion is secured, together with even increased efficiency in the matter of illumination.

Flash light.—The simplest method is to blow a quantity of powdered magnesium into a gas flame, or the flame of a spirit lamp, the metal taking fire and burning almost instantly. Many different forms of lamp (both gas and spirit) have been devised for this purpose. One of the most efficient is that of Schirm, in which the magnesium is blown along a cylindrical flame from the inside. In all cases it is essential that the whole of the metal should come into contact with the flame in order to ensure complete combustion. The blast is usually obtained by means of an indiarubber ball or small bellows, and must be strong enough to project the full charge of powder into the flame, but not so powerful that the magnesium is blown through the flame so rapidly that it has not

time to ignite. About 8 grs. of the metal, properly burnt, should be sufficient for an ordinary portrait, but usually a somewhat larger quantity is necessary. Very commonly two or more lamps are used, and they are then connected by means of tubing and fired simultaneously by one and the same blast. The use of more lamps than one has not only the advantage of giving more light, but since they may be arranged at some distance from one another, the light can be diffused without any need for interposing translucent screens, which always cut off a good deal of light. When only one lamp is employed it is necessary to adopt some means of diffusing the light, similar to those employed with the electric arc. For single portraits the lamp or lamps must be placed from 2 to 3 yards from the subject; for groups, three to five lamps will usually be necessary, and the arrangement of them will be governed by circumstances. Large groups in large rooms can be taken successfully in this way, and the magnesium flash light has proved particularly useful for home portraiture.

The arranging and focussing are done by ordinary gas light; the cap is put on, any lights that shine directly into the lens are put out, the shutter of the dark slide is drawn, the cap removed, and the lamps fired. With good lamps the duration of the flash is about one-seventh of a second, so that there is little chance of the subjects moving during the exposure. The flash light, being practically instantaneous, is of great service in photographing animals.

The combustion of the magnesium results in the formation of magnesium oxide, which appears in the form of a white smoke, and is annoying if produced in large quantity, unless removed as quickly as possible. The most successful method of doing this seems to be to fire the lamps under a large hood or cone, consisting of a wooden frame-work, lined on the inside with coarse canvas which is kept moist with water.

Another very convenient method of procuring the rapid combustion of magnesium is to sprinkle the powder on gun-cotton, which is then ignited, and burns almost instantaneously and harmlessly. About 5 grs. of gun-cotton is pulled out as loosely as possible, placed on a very shallow iron or leaden tray, and about 15 grs. of powdered magnesium is sprinkled evenly over it. The gun-cotton is ignited by means of a taper attached to

the end of a stick, and the magnesium burns with it, the rate of combustion being about the same as with a flash lamp. A small screen of tissue paper, ground glass, or muslin should be placed just in front of the gun-cotton, between it and the subject, and a reflector behind the gun-cotton in order to diffuse the light.

In this and all other cases greater efficiency is obtained if the magnesium is burnt in a thin broad flame, with its broad face towards the subject. The gun-cotton, for example, should not be arranged in a square or circular patch, but in a narrow strip, which should be ignited at the middle.

Flash powders.—As already stated, the duration of an ordinary magnesium flash is about one-seventh of a second, and although this is brief enough for ordinary portraiture, it is too long when rapidly moving objects have to be photographed. Much greater rapidity of combustion is obtained by mixing the metal with certain substances rich in oxygen, such as potassium chlorate. A larger quantity of magnesium can be burnt in this way than is practicable in flash lamps or with gun-cotton.

It is very important to bear in mind that these magnesium flash powders are really explosives, and must be treated with all the respect due to such compounds. Several fatal accidents have been caused in America by carelessness in this respect. With proper precautions, however, they can be used with safety.

The points that must be specially observed are as follows:—The ingredients must be kept separate, and must only be mixed immediately before they are required for use; any rubbing or powdering must be done whilst the ingredients are separate; mixing should be done on a sheet of paper by means of a knife, or by merely shaking the powders together, great care being taken to avoid pressure or friction; no more should be mixed than is required for use, and the mixed powder should never be kept, much less carried about from place to place.

The powder is placed on a shallow iron or lead tray, and is best ignited by touching it with burning touch-paper—*i.e.*, paper that has been soaked in a strong solution of potassium nitrate, and dried. One end of a small strip of touch-paper may be placed in the flash powder, and when the other end is

ignited it slowly burns down to the powder. For portraits, however, the burning paper should be applied directly. A quantity of powder containing 15 grs. of magnesium is amply sufficient for an ordinary portrait. The powder should not be piled in a heap, but should be arranged in a long narrow strip, as in the case of the gun-cotton. If necessary, reflectors and screens must be used as already described.

A very good mixture is that of Müller :—

Potassium perchlorate	3 parts.
Potassium chlorate	3 ,,
Magnesium powder	4 ,,

The chlorate and the perchlorate may be very finely powdered and mixed together, but the chlorate mixture and the magnesium must be kept separate until wanted for use. 20 grs.(2 parts) of magnesium is mixed on a sheet of paper as already described, with 60 grs. (3 parts) of the mixture of perchlorate and chlorate. The duration of the flash is from one-eightieth to one-twentieth of a second.

Whilst this powder may be safely burnt in small quantities, the combustion is so violent that it cannot be used in large quantities without danger. When a large quantity of light is required, a mixture that burns more slowly must be used. A mixture of magnesium powder with an equal weight, or one and a half times its weight, of potassium nitrate, prepared with all the precautions previously insisted on, may be burnt in large quantity without detonation or explosion. When a great space has to be illuminated, and large quantities of powder are burnt, it becomes of the greatest importance to spread it out in a moderately long strip, and not to pile it in a heap. In such case it should be fired at the middle with a fuse of touch-paper, the photographer standing at a safe distance.

Gas and Petroleum.—Although gas light and lamp light may often be conveniently used for copying, especially if good Argand gas burners or circular wick lamp burners be used, their application is limited. The use of orthochromatic plates, with their sensitiveness to yellow rays, greatly reduces the exposure required, and opens up new possibilities in the use of these sources of illumination. With an illumination equal to 150 candles, obtained by means of large Belge petroleum lamps, using plates sensitised with an ammoniacal solution

of erythrosin, portraits have been obtained with exposures not much longer than those required in an ordinary studio.

The great improvements that have been made in the incandescent gas burners, both as regards the resisting power of the mantle and the intensity and photographic activity of the light, have made it quite practicable to use a series or "battery" of such burners, for studio exposures. One burner has an illuminating power equal to about 60 standard candles, and it is obvious that, say, twenty such burners, properly arranged, will give very powerful illumination.

Acetylene is at least as effective as the incandescent gas burners for all kinds of photography with artificial light, and may be used with advantage in places where ordinary gas is not available.

TABLE 1.

ENGLISH WEIGHTS AND MEASURES.

AVOIRDUPOIS WEIGHT.

437·5 grains (gr.) = 1 ounce (oz.).
7000 grains = 16 ounces = 1 pound (lb.).

14 lb. = 1 stone. 112 lb. = 1 hundredweight (cwt.). 20 cwt. = 1 ton.

Avoirdupois weight is the weight always used in buying and selling chemicals and all other commodities, except precious stones, and precious metals *in the metallic state.* For the latter purpose Troy weight is used.

TROY WEIGHT.

24 grains = 1 pennyweight (dwt.).
480 grains = 20 pennyweights = 1 ounce (oz. troy.).
5760 grains = 240 pennyweights = 12 ounces = 1 pound (lb. troy.).

APOTHECARIES' WEIGHT has not for many years been legal for buying and selling, and is used by pharmacists *only* when compounding prescriptions.

IMPERIAL FLUID MEASURE.

437·5 fluid grains* = 1 fluid ounce.†
8750 fluid grains = 20 fluid ounces = 1 pint.
17,500 fluid grains = 40 fluid ounces = 2 pints = 1 quart.
70,000 fluid grains = 160 fluid ounces = 8 pints = 4 quarts = 1 gallon.

APOTHECARIES' FLUID MEASURE.

60 minims (min.) = 1 drachm (dm.).
480 minims = 8 drachms = 1 ounce.

The fluid ounce, both in Imperial measure and Apothecaries' measure, is the bulk of the Avoirdupois ounce (437·5 grains) of water at 60° Fahr. In Apothecaries' fluid measure, however, this ounce is divided into 480 parts, or minims, whilst the ounce *weight* is divided into only 437·5 parts, or grains, the latter being also the case with the fluid ounce in Imperial measure.

The minim, therefore, does not weigh a grain, and is not equivalent to a fluid grain; it weighs 0·91 grain, and is equivalent to 0·91 fluid grain.

To convert *grains per ounce* into *parts per thousand* (or grammes per litre) divide by 0·44.

To convert *parts per* 1000 (or grammes per litre) into *grains per ounce* multiply by 0·44.

* Fl. gr. † Fl. oz.

TABLE 2.

FRENCH, OR METRIC SYSTEM OF WEIGHTS AND MEASURES.

MEASURES OF LENGTH.

10 millimetres (mm.) = 1 centimetre (cm.).
100 millimetres = 10 centimetres = 1 decimetre (dm.).
1000 millimetres = 100 centimetres = 10 decimetres = 1 metre (m.).
1000 metres = 1 kilometre (km.).

Centimetres and metres are used in ordinary measurements, the former for small and the latter for larger distances; millimetres are used for the small magnitudes frequently dealt with in science; decimetres, decametres (10 metres), and hectometres (100 metres) are seldom used.

MEASURES OF CAPACITY.

Square and cubic measure from the measures of length as in the English system.

1000 cubic centimetres (c.c.) = 1 cubic decimetre = 1 litre.

The litre is the measure by which ordinary quantities of liquids are measured and sold on the Continent.

Small volumes are usually expressed in cubic centimetres and decimal fractions thereof; large volumes in cubic metres.

WEIGHT.

10 milligrammes (mgm.) = 1 centigramme (cgm.).
100 milligrammes = 10 centigrammes = 1 decigramme (dgm.).
1000 milligrammes = 100 centigrammes = 10 decigrammes = 1 gramme (gm.).
1000 grammes = 1 kilogramme (kg.).

Small quantities, such as photographers deal with in making up formulæ, are always expressed in grammes and decimal fractions thereof; large quantities are expressed in kilogrammes.

A gramme is the weight of one cubic centimetre of pure water at a temperature of 4° Cent. (39·4° Fahr.) in the latitude of Paris, and there is thus a very simple relation between the measures of length, capacity, and weight in this system.

Table 3.

THE ENGLISH SYSTEM AND THE METRIC SYSTEM.

1 metre = 39·37 inches (approximately
1 litre (1000 c.c.) = 1·76 pint (approximately 1¾).
1 gramme = 15·4323 grains (approximately 15⅖).
1 kilogramme = 2·205 lb. avdp. (approximately 2⅕).

1 inch = 2·54 centimetres (approximately 2½).
1 fluid ounce = 28·35 cubic centimetres (approximately 28⅓).
1 ounce avdp. = 28·35 grammes (approximately 28⅓).
1 pound avdp. = 453·6 grammes (approximately 453½).

The most important relations to remember are those between the centimetre and the inch; the gramme and the grain; the gramme and the ounce; the cubic centimetre and the fluid ounce.

RULES FOR CONVERSION.

To convert centimetres into inches: divide by 2·54 (2½).
" inches into centimetres: multiply by 2·54 (2½).

" millimetres into inches: divide by 25·4 (25½).
" inches into millimetres: multiply by 25·4 (25½).

" metres into yards: multiply by 1·
" yards into metres: divide by 1·094

To convert cubic centimetres into fluid ounces: divide by 28·35 (28⅓)
" fluid ounces into cubic centimetres: multiply by 28·35

" litres into pints: multiply by 1·76 (1¾).
" pints into litres: divide by 1·76 (1¾).

To convert grammes into grains: multiply by 15·43 (15½).
" grains into grammes: divide by 15·43 (

grammes into ounces (avdp.): divide by 28·35 (
ounces (avdp.) into grammes: multiply by 28·35 (28⅓).

kilogrammes into pounds (avdp.): multiply by 2·205 (2⅕).
pounds (avdp.) into kilogrammes: divide by 2·205 (2⅕).

TABLE 4.

ILFORD FORMULÆ IN METRIC MEASURES.

ILFORD PLATES.

WORKING SOLUTIONS.

No. 1.		No. 2.	
Stock Solution of Pyro A or B	25 to 50 c.c.	Sodium Carbonate ...	50 grms.
Water to make up to...	500 c.c.	Sodium Sulphite ...	50 "
		Potassium Bromide ...	1·2 "
		Water to make up to ..	500 c.c.

STOCK SOLUTION.

Pyro	28·4 grms.
Potassium Metabisulphite	5 "
Water	150 c.c.

ALUM BATH.—Alum, 30 grms., Water, 400 c.c.

FIXING.—Hypo, 400 grms., Water, 1000 c.c.

ILFORD P.O.P.

HARDENING BATH.—Alum, 45 grms., Common Salt, 30 grms., Water, 600 c.c.

TONING.

No. 1.		No. 2.		No. 3.	
Ammonium Sulpho-cyanide...	8 grms.	Sodium Sulphite	0·8 grms.	Gold Chloride (15 grn. tube)	1 grm.
Water ...	350 c.c.	Water ...	350 c.c.	Water ...	425 c.c.

FIXING.—Hypo, 75 grms., Water, 500 c.c.

ILFORD BROMIDE PAPER AND OPALS.

DEVELOPER.

No. 1.		No. 2.	
Metol	4 grms.	Sodium Carbonate ...	17½ grms.
Hydroquinone ...	2 "	Potassium Bromide ...	2·4 "
Sodium Sulphite ...	35	Water up to	700 c.c.
Water up to	700 c.c.		

FIXING.—Hypo, 100 grms., Water, 500 c.c.

ALTERNATIVE DEVELOPER.

No. 1.		No. 2.	
Sulphate of Iron ...	50 grms.	Potassium Oxalate ...	200 grms.
Sulphuric Acid ...	10 drops.	Potassium Bromide ...	1 grm.
Warm water up to ...	200 c.c.	Warm water up to ...	800 c.c.

CLEARING SOLUTION.—Glacial Acetic Acid, 10 c.c., Water, 1600 c.c.

TABLE 5.

TABLE FOR ENLARGEMENTS.

From the "British Journal of Photography Almanac."

FOCUS OF LENS.	TIMES OF ENLARGEMENT AND REDUCTION.							
	1	2	3	4	5	6	7	8
inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
2	4 4	6 3	8 $2\frac{2}{3}$	10 $2\frac{1}{2}$	12 $2\frac{2}{5}$	14 $2\frac{1}{3}$	16 $2\frac{2}{7}$	18 $2\frac{1}{4}$
$2\frac{1}{2}$	5 5	$7\frac{1}{2}$ $3\frac{3}{4}$	10 $3\frac{1}{3}$	$12\frac{1}{2}$ $3\frac{1}{8}$	15 3	$17\frac{1}{2}$ $2\frac{11}{12}$	20 $2\frac{6}{7}$	$22\frac{1}{2}$ $2\frac{13}{16}$
3	6 6	9 $4\frac{1}{2}$	12 4	15 $3\frac{3}{4}$	18 $3\frac{3}{5}$	21 $3\frac{1}{2}$	24 $3\frac{3}{7}$	27 $3\frac{3}{8}$
$3\frac{1}{2}$	7 7	$10\frac{1}{2}$ $5\frac{1}{4}$	14 $4\frac{2}{3}$	$17\frac{1}{2}$ $4\frac{3}{8}$	21 $4\frac{1}{5}$	$24\frac{1}{2}$ $4\frac{1}{12}$	28 4	$31\frac{1}{2}$ $3\frac{15}{16}$
4	8 8	12 6	16 $5\frac{1}{3}$	20 5	24 $4\frac{4}{5}$	28 $4\frac{2}{3}$	32 $4\frac{4}{7}$	36 $4\frac{1}{2}$
$4\frac{1}{2}$	9 9	$13\frac{1}{2}$ $6\frac{3}{4}$	18 6	$22\frac{1}{2}$ $5\frac{5}{8}$	27 $5\frac{2}{5}$	$31\frac{1}{2}$ $5\frac{1}{4}$	36 $5\frac{1}{7}$	$40\frac{1}{2}$ $5\frac{1}{16}$
5	10 10	15 $7\frac{1}{2}$	20 $6\frac{2}{3}$	25 $6\frac{1}{4}$	30 6	35 $5\frac{5}{6}$	40 $5\frac{5}{7}$	45 $5\frac{5}{8}$
$5\frac{1}{2}$	11 11	$16\frac{1}{2}$ $8\frac{1}{4}$	22 $7\frac{1}{3}$	$27\frac{1}{2}$ $6\frac{7}{8}$	33 $6\frac{1}{2}$	$38\frac{1}{2}$ $6\frac{5}{12}$	44 $6\frac{2}{7}$	$49\frac{1}{2}$ $6\frac{3}{16}$
6	12 12	18 9	24 8	30 $7\frac{1}{2}$	36 $7\frac{1}{5}$	42 7	48 $6\frac{6}{7}$	54 $6\frac{3}{4}$
7	14 14	21 $10\frac{1}{2}$	28 $9\frac{1}{3}$	35 $8\frac{3}{4}$	42 $8\frac{2}{5}$	49 $8\frac{1}{6}$	56 8	63 $7\frac{7}{8}$
8	16 16	24 12	32 $10\frac{2}{3}$	40 10	48 $9\frac{3}{5}$	56 $9\frac{1}{3}$	64 $9\frac{1}{7}$	72 9
9	18 18	27 $13\frac{1}{2}$	36 12	45 $11\frac{1}{4}$	54 $10\frac{4}{5}$	63 $10\frac{1}{2}$	72 $10\frac{2}{7}$	81 $10\frac{1}{8}$

Look out the focal length of the lens in the left hand vertical column and follow the horizontal line of figures opposite to it. Look out, also,

the number of times of enlargement or reduction, as the case may be, in the top horizontal line, and follow that column vertically downwards. The two numbers at the junction of the vertical column below the number of times of enlargement or reduction with the horizontal line opposite the focal length of the lens, give the distances of the negative and plate respectively from the lens. If an enlargement is being made, the larger number is the distance of the plate or paper from the lens, and the smaller is the distance of the negative; if a reduction is being made, the larger number is the distance of the negative, and the smaller is the distance of the plate. For example, to enlarge five times with a lens of 6 inches focal length, the paper must be 36 inches and the negative 7½ inches from the lens. If the focal length of the lens is greater than 9 inches, look out half the focal length in the first vertical column, and multiply the numbers found for the distances by two.

Table 6.

DR. WOODMAN'S TABLE OF VIEW ANGLES.

DIVIDE THE BASE OF THE PLATE BY THE EQUIVALENT FOCUS OF THE LENS.

IF THE QUOTIENT IS	THE ANGLE IS	IF THE QUOTIENT IS	THE ANGLE IS	IF THE QUOTIENT IS	THE ANGLE IS
	Degrees.		Degrees.		Degrees.
·282	16	·748	41	1·3	66
·3	17	·768	42	1·32	67
·317	18	·788	43	1·36	68
·335	19	·808	44	1·375	69
·353	20	·828	45	1·4	70
·37	21	·849	46	1·427	71
·389	22	·87	47	1·45	72
·407	23	·89	48	1·48	73
·425	24	·911	49	1·5	74
·443	25	·933	50	1·53	75
·462	26	·954	51	1·56	76
·48	27	·975	52	1·59	77
·5	28	1·	53	1·62	78
·517	29	1·02	54	1·649	79
·536	30	1·041	55	1·678	80
·555	31	1·063	56	1·7	81
·573	32	1·086	57	1·739	82
·592	33	1·108	58	1·769	83
·611	34	1·132	59	1·8	84
·631	35	1·155	60	1·833	85
·65	36	1·178	61	1·865	86
·67	37	1·2	62	1·898	87
·689	38	1·225	63	1·931	88
·708	39	1·25	64	1·965	89
·728	40	1·274	65	2·	90

Table 7.

THERMOMETER SCALES.

CONVERSION OF FAHRENHEIT DEGREES INTO CENTIGRADE DEGREES.

FAHRENHEIT.	CENTIGRADE.	FAHRENHEIT.	CENTIGRADE.	FAHRENHEIT.	CENTIGRADE.
+212	+100	+172	+77·78	+132	+55·55
211	99·44	171	77·22	131	55
210	98·89	170	76·67	130	54·44
209	98·33	169	76·11	129	53·89
208	97·78	168	75·55	128	53·33
207	97·22	167	75	127	52·78
206	96·67	166	74.44	126	52·22
205	96·11	165	73·89	125	51·67
204	95·55	164	73·33	124	51·11
203	95	163	72·78	123	50·55
202	94·44	162	72·22	122	50
201	93·89	161	71·67	121	49·44
200	93·33	160	71·11	120	48·89
199	92·78	159	70·55	119	48·33
198	92·22	158	70	118	47·78
197	91·67	157	69·44	117	47·22
196	91·11	156	68·89	116	46·67
195	90·55	155	68·33	115	46·11
194	90	154	67·78	114	45·55
193	89·44	153	67·22	113	45
192	88·89	152	66·67	112	44·44
191	88·33	151	66·11	111	43·89
190	87·78	150	65·55	110	43·33
189	87·22	149	65	109	42·78
188	86·67	148	64·44	108	42·22
187	86·11	147	63·89	107	41·67
186	85·55	146	63·33	106	41·11
185	85	145	62·78	105	40·55
184	84·44	144	62·22	104	40
183	83·89	143	61·67	103	39·44
182	83·33	142	61·11	102	38·89
181	82·78	141	60·55	101	38·33
180	82·22	140	60	100	37·78
179	81·67	139	59·44	99	37·22
178	81·11	138	58·89	98	36·67
177	80·55	137	58·33	97	36·11
176	80	136	57·78	96	35·55
175	79·44	135	57·22	95	35
174	78·89	134	56·67	94	34·44
173	78·33	133	56·11	93	33·89

FAHRENHEIT.	CENTIGRADE.	FAHRENHEIT.	CENTIGRADE.	FAHRENHEIT.	CENTIGRADE.
+ 92	+33·33	+47	+8·33	+3	—16·11
91	32·78	46	7·78	2	16·67
90	32·22	45	7·22	1	17·22
89	31·67	44	6·67	0	17·78
88	31·11	43	6·11	—1	18·33
87	30·55	42	5·55	2	18·89
86	30	41	5	3	19·44
85	29·44	40	4·44	4	20
84	28·89	39	3·89	5	20·55
83	28·33	38	3·33	6	21·11
82	27·78	37	2·78	7	21·67
81	27·22	36	2·22	8	22·22
80	26·67	35	1·67	9	22·78
79	26·11	34	1·11	10	23·33
78	25·55	33	0·55	11	23·89
77	25	32	0	12	24·44
76	24·44	31	—0·55	13	25
75	23·89	30	1·11	14	25·55
74	23·33	29	1·67	15	26·11
73	22·78	28	2·22	16	26·67
72	22·22	27	2·78	17	27·22
71	21·67	26	3·33	18	27·78
70	21·11	25	3·89	19	28·33
69	20·55	24	4·44	20	28·89
68	20	23	5	21	29·44
67	19·44	22	5·55	22	30
66	18·89	21	6·11	23	30·55
65	18·33	20	6·67	24	31·11
64	17·78	19	7·22	25	31·67
63	17·22	18	7·78	26	32·22
62	16·67	17	8·33	27	32·78
61	16·11	16	8·89	28	33·33
60	15·55	15	9·44	29	33·89
59	15	14	10	30	34·44
58	14·44	13	10·55	31	35
57	13·89	12	11·11	32	35·55
56	13·33	11	11·67	33	36·11
55	12·78	10	12·22	34	36·67
54	12·22	9	12·78	35	37·22
53	11·67	8	13·33	36	37·78
52	11·11	7	13·89	37	38·33
51	10·55	6	14·44	38	38·89
50	10	5	15	39	39·44
49	9·44	4	15·55	40	40
48	8·89				

Table 8.

A STANDARD METHOD OF DEVELOPMENT.

("*Journal of the Photographic Society of Great Britain*"—XIV., 134—142.)

After making a large number of experiments, the author brought before the Photographic Society of Great Britain, in 1890, the following proposed standard methods of development for use in comparing the sensitiveness of plates, or for any other scientific purposes. The composition of the proposed standard developers agrees very closely with that of the developers in common use; the proportions of the constituents are simple, the materials are readily obtained in a state of purity, and the solutions are easily prepared; the developers will not produce chemical fog on plates of good quality when allowed to act for a time sufficient to develop the maximum possible amount of detail.

Standard Pyro.-Ammonia.

A.

Real ammonia, NH_3	5 parts.
Ammonium bromide	10 ,,
Water, *up to*	1000 ,,

B.

Pyro.	10 parts.
Water, *up to*	1000 ,,

Mix in equal volumes immediately before use, and develop for ten minutes in an open dish, with occasional rocking, at 15° Cent. (60° Fahr.). The mixed developer contains in 1000 parts: 2·5 parts real ammonia, NH_3, 5 parts ammonium bromide, and 5 parts pyro. The pyro. solution must be freshly prepared; the ammonia solution may be kept for some time.

Standard Pyro.-Soda.

A.

Sodium carbonate (anhydrous)	20 parts.
Potassium bromide	5 ,,
Water, *up to*	1000 ,,

B.

Pyro.	10 parts.
Water, *up to*	1000 ,,

Mix in equal volumes immediately before use, and develop for thirty minutes in a closed vessel at 15° Cent. (60 Fahr.). The mixed developer contains in 1000 parts; Sodium carbonate, 10 parts; potassium bromide, 2·5 parts; pyro., 5 parts. The sodium carbonate solution may be kept for some time.

APPENDIX

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PHOTOGRAPHIC CHEMICALS, HOW TO KEEP AND HOW TO USE THEM.

C. H. BOTHAMLEY, F.I.C., F.C.S., F.R.P.S.

EVERY photographer, except those amateurs who buy all their developers and other solutions ready made, without having any clear idea as to what they contain, is sure to become acquainted before long with the properties, both useful and troublesome, of ordinary photographic chemicals. Amongst other things, he will find that some of them are liable to alter if kept, or in ordinary language to "go bad"; and unless he has some chemical knowledge, he will be puzzled to know what has happened, why it has happened, and to what extent it is likely to interfere with the use of the particular substance.

This article has been compiled with a view to give concise information about the changes to which photographic chemicals are liable, and how they should be kept, and it has been thought useful to add some notes on the making of solutions.

The Ways in which Photographic Chemicals deteriorate.—Very few of the chemical compounds used by photographers are liable to decompose spontaneously, by reason of some inherent instability. Any deterioration that may take place is due as a rule to the action of some one or more constituents of the air, or to the action of light, in conjunction, as a rule, with the air.

The constituents of the air that chiefly affect photographic chemicals are oxygen, water vapour, and carbon dioxide or carbonic acid gas.

Combination with the oxygen of the air, generally spoken of as *oxidation*, takes place in the case of most developers in neutral or alkaline solutions, and also with iron sulphate and other ferrous salts, sulphites, and metabisulphites. In the case of developers the change is generally indicated by discoloration; in other instances transparent crystals become opaque; in others there is no visible change at all. In order to reduce oxidation to a minimum, the substances must be kept in very well-closed bottles, which they should fill as nearly as possible, so that very little air may be left in the bottle.

Carbonation by absorption of carbon dioxide from the air is observed in the case of the caustic alkalis—ammonia, caustic potash, and caustic soda. In solution there is no outward sign, but the solid caustic alkalis increase in bulk, and become much softer when they are carbonated in this way.

Water vapour is absorbed from the air by a considerable number of substances, which are said to be *hygroscopic*. The practical result is that the substance weighed out is a mixture of the particular compound and water, instead of consisting of the compound alone, and consequently the solutions made with it are weaker than they ought to be. Very hygroscopic substances, that absorb so much water from the air that they become liquid, are said to *deliquesce* or to be *deliquescent*; calcium chloride, caustic potash, caustic soda, lithium bromide, potassium carbonate, zinc bromide, and ammonium and potassium sulphocyanides have this property.

A few substances, like soda crystals, which contain a large proportion of water in the form of "water of crystallisation," lose some of this water when exposed to the air, the transparent crystals becoming opaque and crumbling down to powder. Such compounds are said to *effloresce* or to be *efflorescent*. It is obvious that a given weight of the effloresced substance will contain more *of the salt* than an equal weight of the non-effloresced crystals.

Light changes many other compounds besides silver salts, and generally acts only in presence of air. Potassium ferricyanide, ammonium sulphocyanide, gold chloride, ferric sodium oxalate, and ferric potassium oxalate are the chief photographic chemicals that are affected in this way.

Some substances act on glass, especially when they are in the form of aqueous solutions. Amongst these may be mentioned caustic potash, caustic soda, potassium carbonate, and sodium carbonate. Hard pale green glass is the least readily attacked, whilst white lead glass, dark blue glass, and soft dark green glass are the most easily attacked.

Some chemicals, such as ether and acetone, are very volatile, and escape from all but the most carefully closed vessels, especially in warm weather.

In what follows it is assumed that the compounds are of a reasonable degree of purity, and that the solutions have been made with distilled water, or at any rate with soft water; *that they have been put into clean bottles*, and are kept in fairly cool places without exposure to strong sunlight. Impure chemicals and careless and dirty manipulation might lead to different results.

Acetic Acid does not alter under any ordinary conditions, except that the purest form, known as "glacial" acetic acid, will absorb moisture from the atmosphere, and thus become slightly diluted. The strong acid acts gradually on ordinary corks.

Acetone undergoes no alteration, but has a low boiling point, and hence will gradually volatilise, especially in hot weather, unless kept in securely corked or very well-stoppered bottles. India-rubber corks cannot be used.

Adurol, in the solid state, is but little, if at all, affected by air, even after a long time. Its aqueous solution alters very slowly; and a solution containing also potassium metabisulphite remains practically unchanged, at any rate as far as developing power is concerned, for a very long time.

Alcohol absorbs water vapour from the air, and thus becomes a little diluted. When pure, it will gradually evaporate, unless kept in a tightly closed bottle.

Alcohol (Methylated).—See *Alcohol.*

Alum, when pure, does not change either in the solid state or in solution. Sometimes a precipitate of alumina forms in the solution, but does not interfere with its use; it is attributable to the presence of basic alum or some other impurity in the alum, or to the use of hard water for making up the solution.

Amidol combines with the oxygen of the air, and forms dark-coloured products. The change is gradual and comparatively superficial in the solid state, but is somewhat rapid in solution It follows that this substance should always be kept in the solid form, and the bottle should be corked with special care.

Ammonia (or "Liquor Ammoniæ") is a strong solution of the gas in water. The gas readily escapes, especially from a strong solution and in warm weather. The best plan is to dilute the strong solution with water up to ten times its original volume as soon as it is purchased. The diluted solution should be kept in a bottle with a glass stopper or an indiarubber cork. It tends to absorb carbon dioxide from the air, with formation of ammonium carbonate, but as a rule this change takes place very slowly.

Ammonium Bromide when solid absorbs a little moisture from the air, but otherwise does not alter either in the solid state or in solution.

Ammonium Carbonate, so called, is a mixture of the true ammonium carbonate with another substance—ammonium carbamate. In the solid state it gradually gives off ammonia gas, and tends to change into ammonium hydrogen carbonate. A similar change takes place after the substance has been dissolved in water, and consequently the composition of the solution is always somewhat uncertain.

Ammonium Persulphate in the solid state is not absolutely stable even at ordinary temperatures, but alters very slowly. Its aqueous solution alters much more rapidly with liberation of oxygen and loss of its special properties, and should not be kept more than four or five days.

Ammonium Sulphocyanide absorbs moisture somewhat readily from the air, and may even deliquesce (p. 190). It sometimes becomes pink when exposed to light; but this change is usually slight, and does not interfere with the ordinary use of the compound.

Borax does not alter either in the solid state or in solution.

Copper Sulphate does not change in the solid state. The aqueous solution sometimes deposits a small quantity of a greenish-blue precipitate of a basic copper sulphate; but this is the only change, and the effect on the strength of the solution is trifling.

Calcium Bromide readily absorbs water from the air and deliquesces (p. 190). Its aqueous solution does not alter.

Calcium Chloride also readily absorbs water from the air and deliquesces. Its use as a drying agent depends on this property. The damp substance should be placed in a clean earthenware dish or plate, and put on the top of an oven. When apparently dry it should be put inside the oven, and, after being made very hot for twenty minutes or half an hour, should be re-bottled and corked up with an indiarubber cork whilst still warm.

Catechol.—See *Pyrocatechin.*

Caustic Potash.—See *Potassium Hydrate.*

Caustic Soda.—See *Sodium Hydrate.*

Chrome Alum behaves in the same way as ordinary alum.

Developers all alter more or less when in contact with air, and their tendency to oxidise has no definite relation to their developing power. They alter more readily when in solution than when solid, and the change is most marked when the solution is alkaline. When the solution is acid, the tendency to oxidise is much less, and in some cases there is practically no change at all, even after a considerable time.

The alteration of a developer, either solid or liquid, is generally indicated by discoloration, the white or nearly white solid, or colourless solution, becoming first yellow, then brown, and finally almost black; whilst in many cases a precipitate is formed as well. The amount of discoloration is not a very safe guide to the amount of oxidation that has taken place, since some solutions become quite brown, without appreciably losing any developing power. The formation of a precipitate or turbidity may as a rule be regarded as a sign that the solution has become useless.

Diogen gradually oxidises, though not very rapidly, when exposed to air, but does not become very deeply discoloured. The change is much more rapid in presence of an alkali than in a neutral or acid solution.

Eikonogen is slowly oxidised by air, the solid becoming pink or brick red, whilst the solution becomes orange and eventually

brown. A deep orange solution has probably lost much, if not all, of its developing power.

Ether is very volatile, and gradually escapes even at the ordinary temperature. It should be kept in the coolest possible place. In presence of air and moisture (and it generally contains more or less water) it is gradually decomposed by the action of strong light.

Ferric Ammonium Citrate remains unchanged in the dark, but is decomposed by light.

Ferric Chloride.—See *Iron Perchloride.*

Ferric Potassium Oxalate
Ferric Sodium Oxalate } whether solid or in solution decomposes somewhat readily when exposed to even diffused light, but remains unchanged if kept in the dark.

Ferrous Sulphate.—See *Iron Sulphate.*

Formalin, an aqueous solution of formaldehyde, tends to lose strength by volatilisation of the formaldehyde, and the aldehyde also oxidises when exposed to air.

Gelatine, if dry, undergoes no change under any ordinary conditions, but if moist it gradually undergoes putrefactive decomposition, owing to the development of moulds and other low organisms. The solution, even when jellified, is also very liable to decompose, especially in warm weather or if kept in a warm place.

Glycerine does not change under any ordinary conditions, but may absorb a little water if kept in a very moist atmosphere.

Gold Chloride will rapidly absorb moisture from the air and deliquesce ; for this reason it is generally sealed up in glass tubes. In presence of moisture and air it is decomposed by light. An aqueous solution made with distilled water and put into a clean bottle will remain unchanged for a long time if it is not exposed to a bright light. If, however, the solution is made with ordinary water, part of the gold will be reduced and precipitated, the amount of change depending on the quantity of organic matter present in the water. The occurrence of this change is indicated by the solution becoming blue or ruby in colour, or by the formation of a blue or ruby deposit on the bottom and sides of the bottle. It is obvious that when such reduction takes place the solution becomes weaker ; it also as a rule becomes acid.

Gum Arabic, in the solid state, and if kept dry, does not alter. Its aqueous solution somewhat rapidly develops a crop of mould and putrefies, the change being indicated by the appearance of the mould, the smell, and the fact that the solution becomes much less

viscous. The addition of a small quantity of carbolic acid (phenol) generally prevents this change. Oil of cloves may also be used for the same purpose, but is less effective.

Hydrogen Peroxide gradually decomposes under ordinary conditions, the change being retarded by keeping it cool and out of contact with light.

Hydroquinone, when solid, is gradually affected by the air, and becomes brown. It should therefore be kept in very well-closed bottles, though the change is very slow.

The solution is more readily oxidised, especially if even a small quantity of alkali is present, such as is frequently met with as an impurity in sodium sulphite. The solution becomes yellowish and then brown; but it does not alter at all rapidly, and unless it has become markedly brown, it probably retains most of its original developing power. In the absence of any alkali, and especially if the solution is slightly acid, it will remain practically unchanged for a long time.

Hypo.—See *Sodium Thiosulphate.*

Iron Perchloride (or Ferric Chloride) somewhat rapidly absorbs water from the air and deliquesces. It should be kept in a bottle closed with either an indiarubber cork or an ordinary cork carefully paraffined. When dissolved in water there is a tendency to form a deposit of a basic salt, the solution thereby becoming weaker. It is, in fact, difficult to prepare a solution of ferric chloride of any exact strength; but fortunately an approximately known strength is sufficient for most photographic purposes. When the perchloride solution is to be used for etching, as in photogravure, the solution should be made for some time beforehand, and any deposit should be allowed to settle before the specific gravity is taken with the hydrometer. When solutions of different strengths are prepared by adding water to a strong solution, any deposit or precipitate formed should be allowed to settle before the specific gravity is taken. It is always best to allow the solution to stand for three or four days, so that a condition of equilibrium may be attained.

Iron Sulphate (also known as Ferrous Sulphate or Iron Protosulphate) is liable to oxidation. If the crystals are dry, and are kept in a well-corked bottle, they remain unchanged for a very long time; but if moist, or if exposed to a damp atmosphere, they gradually alter, and become brown. They are then useless for the purpose to which iron sulphate is applied in photography. An aqueous solution is still more liable to change, and the oxidation is indicated by a change of colour from very pale green to distinct green, together with, as a rule, the formation of a brownish precipitate. The solution, when made, should be put into small bottles, filled up to the neck, and very well corked.

An apparently similar change, which is, however, really of quite a different kind, occurs when the salt is dissolved in hot water; a brown deposit or precipitate of what is called a basic iron sulphate is formed. This can be dissolved again by adding a few drops of dilute sulphuric acid; but the best plan is to add a little of the acid to the water before putting the iron sulphate in it, and at the same time to take care not to make the solution really hot, but only just warm enough to make the iron salt dissolve fairly quickly. The crystals should be powdered in a mortar before being dissolved.

Kaolin remains quite unaltered.

Lead Acetate remains unchanged, both in the solid state and in solution, after the solution has once been made. In the act of making the solution, however, there is usually a deposit of a white basic lead acetate; but this can be dissolved by cautiously adding acetic acid drop by drop, and shaking vigorously between each addition. It is best to leave a little of the deposit undissolved, and either filter the solution or allow it to stand until clear, and pour off the clear liquid. With "hard" water the quantity of deposit would be larger, and some of it probably would not redissolve.

Lead Nitrate, as lead acetate, except that there should be no deposit when a solution is made with distilled water.

Lithium Bromide readily absorbs water from the air and deliquesces, but does not decompose. In solution it undergoes no change.

Lithium Carbonate does not change.

Magnesium, when exposed to ordinary air, becomes covered with a thin film of the oxide. Magnesium powder should therefore be kept in properly corked bottles, whilst the ribbon or wire, if whitish and lustreless in appearance, should be cleaned by rubbing with fine sand-paper before being burnt.

Mercuric Chloride (or Perchloride of Mercury, also called Corrosive Sublimate) remains unaltered in the solid state, and also in solution, unless the latter is freely exposed to the air, in which case a slight white precipitate may be formed mainly by the action of the small quantity of ammonia vapour that is almost always present in the air.

Metol in the solid form remains unaltered for a long time if kept in a well-corked bottle. Its aqueous solution soon turns brown when exposed to the air; but if it is mixed with sodium sulphite the discoloration is almost prevented, at any rate for a considerable time. In the end the solution becomes yellow and ultimately brown, but it may retain much of its developing power, even after it has become somewhat dark brown, provided that no precipitate has formed.

Ortol behaves in much the same way as hydroquinone, but is even

less liable to discoloration. Both in the solid state and in solution with potassium metabisulphite it remains practically unaltered for a long time.

Platinous Chloride is insoluble in water, and therefore is always used in combination with alkali chlorides (see *Potassium Chloroplatinite*).

Platinic Chloride, when solid, rapidly absorbs moisture from the air and deliquesces. The solution will remain unchanged for a long time.

Potassium Bicarbonate does not alter either when solid or in solution, unless heated, when it gives off carbon dioxide (carbonic acid gas), and becomes partially converted into potassium carbonate.

Potassium Bichromate remains unchanged either in the solid state or in solution, unless mixed with organic matter and exposed to light.

Potassium Bromide, either solid or in solution, remains unchanged.

Potassium Carbonate rapidly absorbs water from the air and deliquesces, but does not decompose, and can be recovered by placing the wet or liquid substance in a clean iron dish and drying, first on an oven top and afterwards inside. A porcelain dish may be used, but is liable to be acted on by the carbonate. In solution it remains unchanged, except that strong solutions slowly attack glass.

Potassium Chloroplatinite is the form in which platinous chloride is used for photographic purposes. It is formed by the combination of platinous chloride with potassium chloride, and in the solid state is a fairly stable compound. It also is not liable to change in solution, except in presence of organic matter, by which it is reduced, the platinum being precipitated and the solution consequently becoming weaker.

Potassium Chromate, as potassium bichromate, except that the solution slowly attacks lead glass (flint glass) if kept in bottles made of it.

Potassium Ferricyanide in the solid state remains unaltered if kept in the dark, but if exposed to strong light becomes partially decomposed on the surface. This holds good of the solution also, except that it decomposes more rapidly and to a greater extent. It follows that the ferricyanide and its solutions should always be kept in the dark or in orange glass bottles.

Potassium Ferrocyanide under ordinary conditions does not alter either in the solid state or in solution. If in any way it comes in contact with acid fumes, it is slightly decomposed and becomes bluish ; but this is not likely to happen except in a laboratory.

Potassium Hydrate (or Hydroxide, commonly called Caustic

Potash) absorbs carbon dioxide from the air and is converted into potassium carbonate, whilst at the same time it absorbs water and deliquesces. It follows that the solid must be kept in bottles closed with indiarubber corks, or with ordinary corks very carefully paraffined over. Glass stoppers would soon become firmly fixed in the neck of the bottle. The aqueous solution likewise absorbs carbon dioxide readily from the air. It also attacks glass, and should be kept only in bottles of hard green glass.

Potassium Iodide remains unaltered under ordinary conditions, whether solid or in solution; but if exposed to strong light in contact with air, it becomes yellowish-brown, owing to the liberation of a small quantity of iodine.

Potassium Metabisulphite in the solid state gradually gives off sulphur dioxide, and tends to change into the ordinary sulphite. At the same time it combines superficially with the oxygen of the air and is converted into potassium sulphate, and consequently the crystals become opaque instead of transparent. Neither of these changes goes on with any marked rapidity or to any great extent in a properly stoppered or corked bottle. Similar changes take place when the salt is in solution, but unless carelessly exposed to the air the amount of alteration is not sufficient to interfere with the use of the solution.

Potassium Nitrite absorbs moisture from the air and deliquesces. Care must therefore be taken that the bottle containing it is made air-tight. The solution is not liable to alter under ordinary conditions.

Potassium Oxalate, whether in the solid state or in solution, does not change under any ordinary circumstances.

Potassium Permanganate does not alter either in the solid state or in solution, unless in contact with organic matter of some kind. The solution attacks many kinds of organic matter, and at the same time is itself reduced, with formation of a brown precipitate.

Potassium Phosphate, whether solid or in solution, remains unchanged.

Potassium Sulphocyanide absorbs moisture from the air and deliquesces. Its aqueous solution very slowly decomposes.

Pyrocatechin (or Catechol) behaves in much the same way as hydroquinone (which see), but its aqueous solution shows a greater tendency to become coloured, especially in presence of any alkali.

Pyrogallol (Pyro or Pyrogallic Acid) in the solid state somewhat rapidly becomes brown if exposed to air. Its aqueous solution also oxidises quickly, and becomes dark brown, but if the solution is acidified the change is almost entirely prevented. It follows that pyrogallol can only be kept in acid solutions, and the best

method is to keep it in solution with potassium metabisulphite or sodium metabisulphite. Strong solutions seem to alter less readily than weak ones. The solution of metabisulphite and pyrogallol becomes yellow immediately after it has been made ; but this slight discoloration may be ignored, and the oxidation goes practically no further even after several months.

Quinol.—See *Hydroquinone.*

Rodinal oxidises if exposed to air, and the change is indicated by a darkening in colour.

Silver Nitrate remains quite unaltered both in the solid state and in solution, provided that it is quite free from organic matter ; but in contact with dust, or with air containing sulphur compounds, the solid substance gradually becomes black at the surface. If the water in which it is dissolved contains any organic matter, a black deposit will be formed until all the organic matter has been decomposed. The quantity of silver nitrate remaining in solution will of course be somewhat reduced, but under ordinary conditions the amount of change is only small. Distilled water, free from any grease, should always be used for making up solutions of silver nitrate.

Soda Crystals, the most familiar form of sodium carbonate, contains when pure as much as 63 per cent. of water and only 37 per cent. of true sodium carbonate. It somewhat rapidly loses water when exposed to air ; and the large transparent crystals crumble down into a powder consisting of very small crystals of monohydrated sodium carbonate, which contains only 14½ per cent. of water and 85½ per cent. of true sodium carbonate. It follows that if this change has been complete, 10 parts of the fine powder contain as much of the carbonate, and therefore will make as strong a solution, as 23 parts of the original transparent crystals. The aqueous solution has the same properties, whichever form of sodium carbonate it is made from. The only change to which it is liable is due to the tendency of the carbonate to act on glass ; and it should be kept in hard green glass bottles, with indiarubber corks or ordinary corks, and not glass stoppers, which would probably become tightly fixed in the bottle neck.

Sodium Acetate does not change in the solid state, but the solution after some time generally contains an abundant fungoid growth, the acetate being partially decomposed. To prevent this growth as far as possible, the solution should be boiled for ten or fifteen minutes, and the bottle should be well stoppered or corked.

Sodium Bicarbonate behaves in the same way as potassium bicarbonate.

Sodium Carbonate occurs in three forms, containing different

proportions of water; namely, ordinary soda crystals, represented in a somewhat impure form by washing soda, monohydrated soda crystals, and anhydrous sodium carbonate. The only change that occurs on keeping is a loss or an absorption of water, and this varies with the original composition of the salt.

Sodium Carbonate (Anhydrous) tends to absorb a little water from the air and change into the following compound.

Sodium Carbonate (Monohydrated) neither absorbs nor loses water; it remains unchanged.

Sodium Carbonate (Decahydrated).—See *Soda Crystals.*

Sodium Chloride remains unchanged, whether solid or in solution.

Sodium Citrate behaves in the same way as sodium acetate.

Sodium Hydrate (or Hydroxide, or Caustic Soda) behaves in the same way as potassium hydrate, though its tendency to absorb water or carbon dioxide, or to act on glass is not quite so great as in the case of potassium hydrate.

Sodium Hyposulphite.—See *Sodium Thiosulphate.*

Sodium Metabisulphite behaves in the same way as potassium metabisulphite (which see).

Sodium Nitrite behaves in the same way as potassium nitrite.

Sodium Phosphate remains unchanged both in the solid state and in solution.

Sodium Phosphate (Tribasic) in the solid state does not alter except in a very moist atmosphere, from which it will absorb some water vapour unless securely corked up. The solution has a tendency to absorb carbon dioxide from the air, and therefore the bottles containing it must be well corked; it is not advisable to use glass stoppers.

Sodium Sulphite, when in the solid state, slowly absorbs oxygen from the air, and is superficially converted into sulphate, the change proceeding further and more rapidly in a moist atmosphere than in a dry one. In properly corked bottles the amount of alteration is as a rule but slight. Aqueous solutions of the sulphite have a greater tendency to absorb oxygen, and the oxidation takes place more rapidly in dilute than in concentrated solutions. It follows that bottles containing the solution must be securely corked or stoppered. When a considerable quantity of the solution is made up at once, it is not advisable to keep it all in one large bottle; the best plan is to put it into several smaller bottles (say 10 oz.), each of which is filled up to the neck. In a properly corked or stoppered bottle a 10 per cent. or 20 per cent. solution of the sulphite will not under any ordinary conditions alter to an extent that will interfere with its efficiency for photographic purposes. even after a considerable time.

Sodium Thiosulphate (or Sodium Hyposulphite), if dry, remains practically unchanged; but if damp through careless manufacture, or if exposed to a moist atmosphere, it slowly absorbs oxygen, and is converted superficially into the sulphate. On the other hand, if the crystals become opaque and crumble to a white powder, this indicates the presence of a considerable proportion of sodium sulphate as an impurity; but this change only takes place in a fairly dry atmosphere. The aqueous solution of sodium thiosulphate slowly absorbs oxygen from the air and is converted into sulphate; but even when the solution has been exposed to the air in dishes the amount of thiosulphate that has been oxidised does not exceed 10 per cent. of the quantity originally present; and the fixing power of the solution is not materially affected, because the reduction in strength due to oxidation is compensated, in part at least, if not entirely, by the increased concentration due to spontaneous evaporation of water from the solution.

Sodium Tungstate does not change either in the solid state or in solution.

Uranium Acetate }
Uranium Nitrate } remain unchanged whether in the solid state or in solution.

Zinc Bromide very readily absorbs water from the air and deliquesces.

How to keep Solids and Solutions.

Since most of the changes described are due to the action of the air, it follows that it is essential to exclude air as far as possible from any solid or solution that is liable to such changes.

Bottles with glass stoppers are often used, but unless the stoppers fit very well indeed (which is often not the case) they are by no means air-tight, and the substance in the bottle may alter continuously. Moreover, with some solutions, and especially with caustic potash, caustic soda, potassium carbonate, and sodium carbonate, glass stoppers are liable to become so firmly fixed in the bottle necks that it is very difficult, if not impossible, to remove them.

Indiarubber corks are much more satisfactory, and can be used with all but a very few photographic chemicals. The cost of bottles with plain necks and indiarubber corks is about the same as the cost of stoppered bottles of good quality, except in the case of wide-mouthed bottles, when the cost of the indiarubber corks is considerably more than the cost of glass stoppers.

Ordinary corks of the best quality make very satisfactory stoppers, provided that they really fit the neck of the bottle. To ensure this, a cork that seems a little too large should be selected,

wrapped in paper, and carefully rolled under the foot on a smooth floor. This softens it and also ensures its being fairly round, so that it fits well into the neck of the bottle.

Two very good methods of improving the air-excluding qualities of corks are (1) to keep them for some time in paraffin wax (pieces of ordinary paraffin candles), melted, say, in a jam-jar on the top of an oven. The corks are taken out whilst hot, and the excess of paraffin removed from the outside by means of a warm dry cloth. (2) They may be kept for some time in a hot solution of gelatine, and then removed and wiped in the manner just indicated.

Substances that are very easily acted on by air in any way, as for example caustic potash or caustic soda, may be dealt with in the following way, if indiarubber stoppers are not available. The cork is selected of such size that, although fitting well, it can be pushed just below the top of the bottle neck. It is then covered carefully with melted paraffin, which is easily done by holding an ordinary paraffin candle in any convenient flame and allowing the melted wax to fall on the cork until the cork and the top edge of the bottle neck are well covered, care being taken, of course, to hold the bottle upright and steady until the melted wax has solidified. The chief drawback to this method is that, unless the cork is removed with great care, a fresh cork is required every time the bottle is opened. It is therefore more suitable for stock bottles than for bottles that are frequently used.

The Making of Solutions.

The making up of solutions is usually a simple matter, involving only a little care and patience, and the possession of some means of weighing, and one or more measures. Some notes on the most convenient and rapid modes of working will, however, probably be helpful to those who have had no previous experience in manipulations of the kind.

For weighing comparatively large quantities, such as a pound or half a pound, ordinary household scales of decent quality will suffice ; but the most convenient is Salter's spring balance, with the pan on the top and a dial indicator. A piece of clean and fairly stiff paper should always be put in the pan before weighing, since if the substance is put directly into the pan the latter will soon become corroded ; and, moreover, it is very difficult to transfer the substance from the pan to the vessel in which it is to be dissolved, whereas with the paper it is easy.

For weighing small quantities the best equipment is a pair of small but good hand-scales, fitted on a stand with a lever for raising

and lowering the scales. To work successfully with the scales held in the hand is inconvenient, and requires much practice. Where expense is a consideration, one of the small quadrant balances with a glass pan, now sold for the purpose, is very convenient, and can be made to answer very well if carefully used.

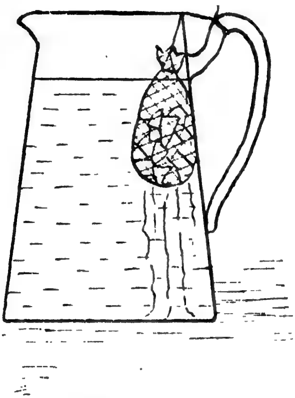


FIG. 50.

When a solution, as is almost always the case, has to be made up to a definite volume or bulk, it is important not to use the full quantity of water when dissolving the substance. Suppose for example, that you wish to make what is commonly called a 10 per cent. solution of, say, sodium sulphite—that is, a solution which contains 10 parts by weight of the solid in 100 parts by volume of the solution, or 1 part by weight (1 oz.) of the solid in 10 parts by volume (10 oz.) of the solution: if you took 10 oz. of water and dissolved 1 oz. of the sulphite in it, the volume of the solution would be considerably more than 10 oz., because the sulphite, although now in solution, still occupies space on its own account.

A safe general rule is to take as many parts less of the liquid as there are parts of the solid to be dissolved. In the example given, you would take 9 oz. of water instead of 10 oz., and dissolve the 1 oz. of sulphite in it If you wished to make a solution of double the strength, you would take only 8 oz. of water and dissolve the 2 oz. of sulphite in it.

After the solid has been dissolved, the solution is poured into a measuring vessel and made up to exactly the right volume by addition of more water if necessary.

The simplest method of making a solution is to put the water (or other liquid) and the substance to be dissolved in a bottle, jug, or other vessel, and either shake repeatedly or keep stirring up with a glass rod until the solid entirely disappears. This is all that is necessary with such easily soluble substances as potassium bromide, ammonium bromide, ammonium sulphocyanide, gold chloride, or pyro.; but with other substances the process would be rather slow. Solution takes place more rapidly when the solid is in fine powder;

and therefore, except in the cases just mentioned, it should be carefully ground up in a mortar before being weighed out.

Another method of accelerating the process is to use hot water instead of cold. Nothing is more convenient for this purpose than ordinary earthenware jugs, but they must be of good quality, since if the glaze cracks it is difficult to keep them clean. The weighed quantity of solid is put into a jug, and the proper quantity of boiling water (which may conveniently be boiled in a small tin kettle over a spirit lamp or oil lamp) is poured over it, and the jug is carefully shaken, or the liquid is stirred, until all the solid has been dissolved. The solution must be allowed to get quite cold before being made up to the exact volume.

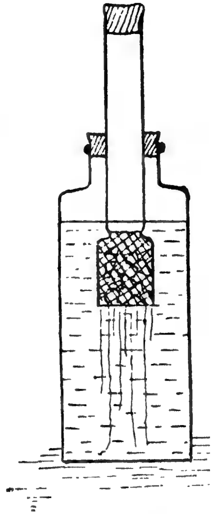


FIG. 51.

When the solution is not wanted immediately, a very simple and convenient plan may be adopted. In fact, on the whole, it is the best plan of all, except in the case of a few special substances like the metabisulphites or iron sulphate, which require special treatment, and in the case of easily soluble substances. If water is poured over a solid and allowed to remain without any shaking, the solid dissolves very slowly, because the solution that is formed is heavier than the water and remains at the bottom, with the result that it surrounds the solid and prevents the access of fresh water, and consequently after a time the process practically ceases. The object of shaking the liquid and solid together is to bring the latter constantly into contact with fresh quantities of the liquid. If now we can so arrange matters that the solid is at the top of the water instead of at the bottom, the solution, as it forms, will sink to the bottom of the liquid, and consequently fresh water will be continually brought into contact with the solid, which will rapidly dissolve. It is easily done. Provide yourself with two or three simple bags of different sizes, made of two thicknesses of fine muslin. First put the proper quantity of (see p. 202) water into a jug, small or large as the case may be. Next put the weighed substance into

a bag of suitable size; tie up the neck of the bag with a clean piece of string, and lower the bag into the jug until it dips into, but is not quite immersed in, the water. Now tie the other end of the string to the jug handle, so that it keeps the bag at the right height (fig. 50). After some little time all the solid will have dissolved, and the bag can be withdrawn and washed ready for use another time. The string should be thrown away.

Not only is this method convenient and very fairly rapid, but it has the advantage that any insoluble impurities remain in the muslin bag, and any necessity for filtering the solution is avoided. If the arrangement is set up overnight, the solution (with all ordinary photographic chemicals) will be ready in the morning.

Substances that are rapidly acted on by air, or that give off gas, like the metabisulphites, can be dealt with in the following way: An ordinary straight lamp chimney, of the kind shown in the illustration, is fitted at the top with a good cork, whilst over the bottom is tied two thicknesses of fine muslin by means of strong cotton or fine string passing round the constriction of the chimney. A wide-mouthed bottle, holding, say, 10 or 20 oz., is fitted with a flat cork or bung, in the middle of which is cut a hole in which the lamp chimney fits fairly tightly. When once fitted together, it is best not to separate the chimney and bung. The metabisulphite, or other substance to be dissolved, is put into the lamp chimney, which is then corked up. The requisite quantity (see p. 202) of water is placed in the wide-mouthed bottle, and the large cork carrying the lamp chimney is fitted into its place, the position of the chimney in the cork being so arranged that the substance to be dissolved is just below the water (fig. 51). Under these conditions the salt dissolves rapidly, just as in the bag and jug method; but the salt and the solution are protected as far as possible from the air. The chimney and muslin are carefully washed after use, and it is not necessary to remove the muslin from the chimney until it is worn out.

Filtering.—When a solution is not clear, but is turbid because the dissolved substance contained some insoluble impurity, or because a deposit or precipitate has been formed, one of two courses may be adopted: the solution, may be allowed to stand until the solid matter has settled, when the clear liquid is poured off; or the liquid may be filtered. The former is the easier, but the latter is the quicker plan, and enables practically all the solution to be used.

Filtration is often effected by means of a special form of porous paper called filter paper; but for ordinary photographic purposes cotton-wool or a piece of fine sponge is the most convenient. Sponge should not be used for solutions of alkalis, but answers very well with solutions of hypo., potassium oxalate, and the like.

An ordinary glass funnel is required, and its size should be in reasonable proportion to the quantity of liquid to be filtered—one of 3 inches diameter and another of 5 or 6 inches diameter will meet all ordinary requirements. The funnel may be supported in the neck of the bottle that is to receive the filtered liquid ; and if the neck is narrow, a small piece of string or a roll of twisted paper should be inserted between the neck of the bottle and the stem of the funnel, in order to provide an outlet for the air in the bottle.

A piece of cotton-wool (or sponge) is selected large enough to fill the apex of the funnel, is moistened with water or the solution to be filtered, and is gently pressed into position. If it fits too tightly, filtration will be slow; if it does not fit tightly enough, filtration will be imperfect and the solution that runs through will not be clear. The liquid should be poured carefully into the funnel, which should be filled to within a quarter of an inch of the top in the case of the small size, and within half an inch of the top in the case of the larger size. When about two-thirds of the solution has run through, the funnel should be filled up again, and this should be continued until all the solution has been filtered.

Hard Water and its Effects.

The use of what is commonly called "hard" water (that is, water containing compounds of calcium and magnesium that it has dissolved in its passage through the soil and rocks) not unfrequently results in the formation of a deposit or "precipitate," due to a reaction between the substances naturally present in the water and the chemicals that have been dissolved in it.

The hardness of water is of two kinds: *temporary hardness*, which can to a large extent be removed by boiling the water for twenty minutes or half an hour, and then filtering or allowing the deposit to settle ; and *permanent hardness*, which cannot be removed in this way. The total amount of hardness, and its division between temporary and permanent, varies greatly in different localities.

Since the effect of the hard water on the solutions made from it depends on the substances naturally present in the water, and since the amount of them is constant for a given quantity of the water, it follows that the effect on the dissolved chemical, if any, is proportionately greater with dilute solutions than with strong solutions. With very hard waters, the amount of change, if any, might, roughly speaking, affect two-thirds of a grain of the substance per fluid ounce of water used, but with ordinary hard waters less than a quarter of a grain per ounce would be affected. This is quite

sufficient to introduce a distinct error in the case of dilute solutions containing only a few grains of the active substance per ounce, but is altogether without any recognisable influence in the case of 5 per cent. or 10 per cent. solutions, except that it may make filtration necessary.

The two cases in which hard water is most troublesome in ordinary photographic practice are (1) when intensifying with mercuric chloride, because hard water tends to precipitate some of the mercury compound in the film, instead of washing it out; and (2) when working with ferrous oxalate, because the whole of the calcium compounds in the water are precipitated in the film or in the solution as a white precipitate of calcium oxalate.

On the whole, temporary hardness is more troublesome to a photographer than permanent hardness, and, as already stated, the inconvenience can be lessened by boiling the water before use. This is especially to be recommended if the water is to be used for making up solutions of a developer.

Gold chloride, mercuric chloride, and silver nitrate solutions should always, if possible, be made up with distilled water, or, failing this, with well-boiled ordinary water. Rain water is not as a rule advisable for making up gold chloride solutions, and is also not unlikely to cause some reduction and precipitation in silver nitrate solutions.

REPORT ON THE NATURE AND CAUSE OF CERTAIN YELLOW STAINS ON GELATINO-CHLORIDE PAPER.

At the request of the Ilford Company, I have investigated the cause of the yellow stains which at times appear on gelatino-chloride paper.

The specimens sent to me showed a disagreeable brownish-yellow stain, which quite spoiled the prints, and which in some cases was uniform, whilst in others it was patchy and irregularly distributed. In many cases the stains were more or less apparent on the back of the paper, as well as on the face of the print. The intensity of the stain varied considerably in different cases.

The accounts given of the manner in which the paper had been manipulated threw very little light on the origin of the stains, and seemed to indicate that care had been taken in the washings, etc. It may be stated here, however, that this latter indication is not confirmed by the result of the investigation.

The most remarkable point, however, and one in which all the statements, with a single exception, agreed, is that the stains *appeared during the washing between toning and fixing*. Their general appearance indicated that the stains were due to the deposition of silver sulphide. In all cases the ammonium sulphocyanide toning bath had been used.

In my own experience of the paper, which has been not inconsiderable, and has involved the use of various toning baths, no stains of this kind have ever been met with, and the investigation was directed with a view to ascertain not only to what cause the stains are due, but also to what causes they are not due.

Experiments were made with paper of the three ordinary colours, white, pink, and mauve, and three distinct samples of ammonium sulphocyanide were used, two of these being obtained from well-known dealers in chemicals, whilst the third had been sent to the Ilford Company as being part of a sample that had been used in making up a toning bath, with which the yellow stains had been observed.

Many experiments were made, but it will not be necessary to refer specifically to more than a few of them.

Paper was carefully washed until all soluble silver salts had been removed, and was then immersed for some time in solutions of each of the three samples of sulphocyanide of the strength used in

the toning bath. The paper was afterwards carefully washed. *No stains.*

Paper *without any washing* was immersed in the sulphocyanide solutions for some time, and then thoroughly washed. *No stains.*

Paper, part of which had been exposed to light, was thoroughly washed, and then immersed in the sulphocyanide toning bath until fully toned, three separate toning baths being made up with the three samples of sulphocyanide. After toning, the prints were washed in the usual way. *No stains.*

Paper, part of which had been exposed to light, was immersed, *without any previous washing*, in each of the three toning baths until fully toned, and was afterwards washed as usual. *No stains.*

Paper, partly printed upon as in the preceding experiments, was carefully washed, toned in each of the three toning baths, and then washed, *a very small quantity of hypo.* (sodium thiosulphate) *being added to the first wash-water.* The washing was continued in running water for some time, and at first the paper remained perfectly white; but as the washing continued, *dirty yellow stains made their appearance, and when dried the prints were precisely similar to the stained prints about which complaints had been made.*

Paper partly printed upon was toned without any previous washing. No stains appeared whilst in the toning bath. The prints were then placed in a dish of water containing a very small quantity of hypo., and were then washed in several rapid changes of water, and afterwards in running water. At first, the paper remained white, but gradually dark brownish-yellow stains made their appearance.

A portion of a toning bath was sent to me by the Ilford Company as being part of a bath used by a customer on one occasion on which bad yellow stains were produced. I toned in this bath prints upon the three varieties of paper (white, pink, and mauve), both with and without previous washing, but *in no case were any yellow stains produced.*

From these and other experiments, to which detailed reference is unnecessary, I draw the following conclusions :—

1. *The yellow (or brownish-yellow) stains are not due to anything in the paper itself, and with proper manipulation no such stains are produced.*

2. They are not due to any impurity ordinarily present in ammonium sulphocyanide.

3. They are not directly due to imperfect washing before toning, *but, at the same time, this washing should always be carefully done, for other reasons that will appear subsequently.*

4. They are not due to acidity of the sulphocyanide toning

bath, even when it is sufficiently acid to turn blue litmus paper decidedly red.

5. The stains that appear between toning and fixing appear *only when the paper comes into contact with small quantities of hypo.* (sodium thiosulphate) *during the washing that follows toning.* The quantity of hypo. required to produce bad stains is very small, and is such as may easily be introduced into the wash-water in any one of the ways to which reference will be made presently.

The production of the stains in this way is easily explained. It is well known that when hypo. (sodium thiosulphate) comes into contact with silver salts three compounds may be formed—namely, silver thiosulphate, or a silver sodium thiosulphate, or another silver sodium thiosulphate containing a larger proportion of the sodium salt. The first and second of these compounds are insoluble, and are very unstable, decomposing rapidly into dark brown silver sulphide, which, when spread out in a thin film, appears to be brownish-yellow. One or other of these is formed when the quantity of hypo. that comes in contact with the silver salt is small. The third compound is soluble and stable, and is not liable to decompose unless mixed with an acid. It is formed when the hypo. is present in excess.

If the water into which the prints are put when they come out of the toning bath contains a small quantity of hypo., the change that takes place is as follows :—The hypo. acts upon the silver salt in the paper, and produces one of the insoluble and unstable thiosulphates, and the latter decomposes spontaneously as the washing proceeds, producing a small quantity of silver sulphide, which imparts a yellow or brownish-yellow stain to the paper, the depth of the stain depending on the amount of contamination. At first the change is not apparent, but as the decomposition continues the discoloration becomes more marked, and this explains the statement, made by some of the complainers, that the stain became worse the longer the prints were washed.

There is also no difficulty in explaining the fact that in some cases the first prints put into the wash-water showed stains, whilst the remainder show no stains. If the quantity of hypo. with which the water is contaminated is small, it is all absorbed and used up, as it were, by the first lot of prints put in, and consequently, whilst these may be stained, those that follow remain white, because the contamination has been removed from the water before they get into it.

Several different ways in which the wash-water may become contaminated with small quantities of hypo. will readily suggest themselves. The following are amongst the most obvious and probable :—

1. Using for washing after toning a dish that has been used for washing prints or negatives after fixing, or a dish that has been used for fixing prints.

2. Wiping the fingers on a towel or duster that has been used for wiping up hypo. splashes, and afterwards putting the fingers into the wash-water.

3. Putting the fingers into the wash-water after they have been in contact with crystals resulting from the drying up of hypo. splashes on the work-table.

It should be borne in mind that *a very small quantity of hypo. indeed is sufficient to produce the stains.*

In those cases where stains begin to make a frequent appearance, although they have never previously been observed during several months' work, the explanation is probably not so difficult as it might seem at first sight. If, for instance, some hypo. solution has been splashed on the bench or table, and has not been wiped up quickly, part of the solution will have been absorbed by the wood, and even after the table has been wiped down, the hypo. thus absorbed will slowly and gradually make its way to the surface in the form of an efflorescence of minute crystals, and it is obvious that these crystals may very easily get transferred into any dishes, etc., that may be used. This gradual oozing out of the salt from the wood sometimes goes on for several weeks.

In concluding this part of my report, I can only repeat that I have failed altogether to produce the yellow stains between toning and fixing in any way except by allowing the wash-water to become contaminated with small quantities of hypo.

Occasionally, though very rarely, yellow stains appear whilst the prints are in the toning bath. These may be due, and, probably, in most cases, are due, to the accidental introduction of small quantities of hypo. into the bath. If this should happen when the bath has been partially exhausted of its gold, the effect will be just the same as from the introduction of hypo. in the wash-water.

Personally, I have been unable to produce yellow stains in the toning bath, except by the introduction of hypo., but from the evidence of others it would seem that if the same bath is used over and over again, the gold being renewed from time to time, it may in the end begin to decompose in such a way as to produce stains on the prints. The probability of such decomposition is greatly increased if the prints are not properly washed before being toned. The practical conclusion to be drawn is that a new bath should be made up at short intervals. Such a course involves merely a trifling expense, since ammonium sulphocyanide is not costly, and very little is required. Moreover, it is easy to remove practically every trace of the gold from the bath by the action of

the prints, and this can, of course, be done before the old bath is thrown away.

It is stated that sometimes a toning bath begins to decompose so rapidly that gold is deposited all over the surface of the print, from off which it can be rubbed. If ever this should happen it can only be due to the toning bath's having been prepared with very impure materials.

The appearance of yellow stains either in the fixing bath or after fixing is too familiar in the case of all kinds of printing-out paper, and the causes are too well known to require any very detailed enumeration.

The stains that appear whilst prints are in the fixing bath are almost always due to the paper having been put into the bath whilst in an acid condition. In other words, the prints have not been properly washed between toning and fixing. Sometimes the stains are caused by the prints being allowed to stick together. They are thus prevented from coming freely into contact with the hypo. solution, and instead of the soluble stable thiosulphate being formed, the insoluble and unstable compound is produced and decomposes with formation of silver sulphide.

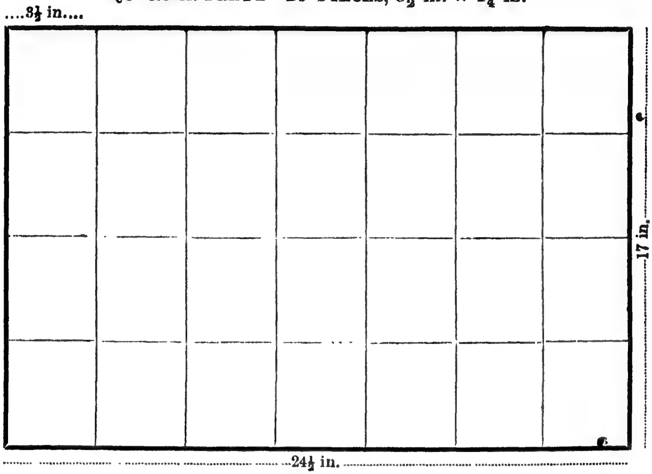
The yellow or brownish-yellow stains that appear after removal of the prints from the fixing bath are due to silver sulphide formed by the decomposition of the unstable compound to which reference has already been made so often. That is to say, the stains are the result of imperfect fixation, which may be due to—(1) Allowing the prints to remain for too short a time in the fixing bath, (2) the use of too weak a solution of hypo., (3) the immersion of too many prints in the same quantity of hypo., (4) the use of an old (and consequently a weakened) solution of hypo., (5) allowing the prints to stick together so that the fixing solution does not come freely into contact with them.

It is perhaps scarcely necessary to point out that all the causes of staining referred to in this report will operate in the case of any print-out paper containing silver salts.

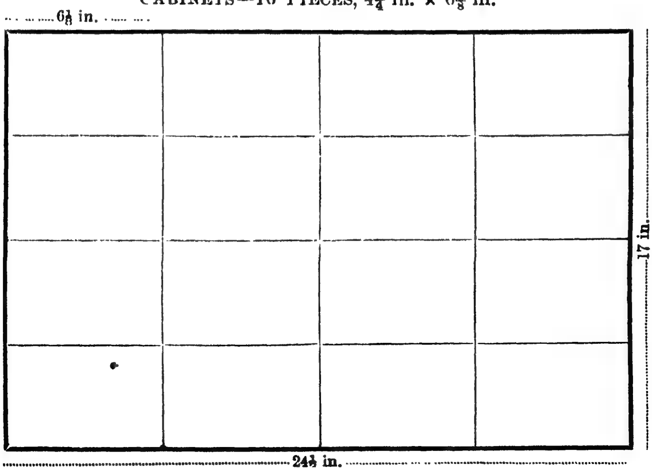
C. H. Bothamley, F.I.C., F.C.S.

ILLUSTRATIONS OF THE METHOD OF CUTTING UP THE ILFORD PRINTING-OUT PAPER.

QUARTER-PLATE—28 PIECES, $3\frac{1}{2}$ in. × $4\frac{1}{4}$ in.

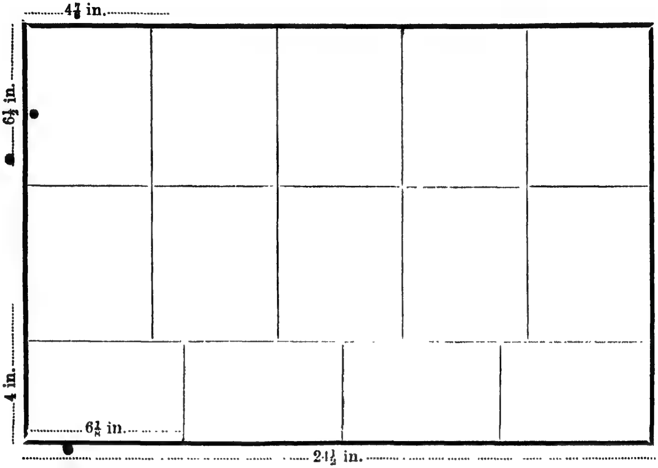


CABINETS—16 PIECES, $4\frac{1}{4}$ in. × $6\frac{1}{8}$ in.

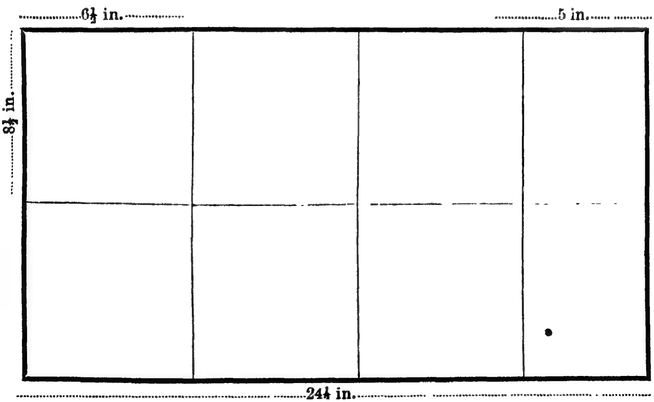


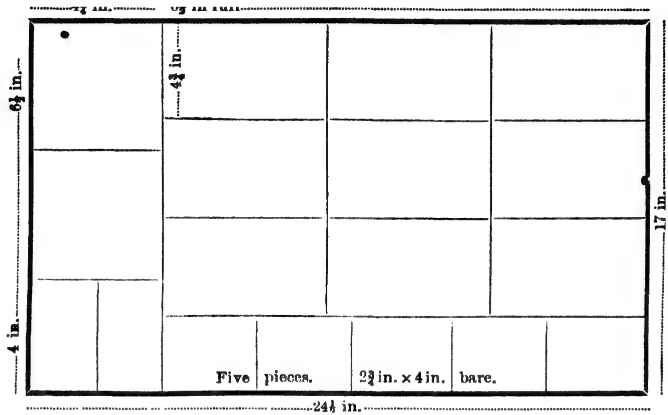
HALF-PLATE—10 PIECES, 6½ in. × 4⅞ in.

4 " 6⅛ in. × 4 in.



WHOLE-PLATE—6 PIECES, 8½ in. × 6½ in.; 2 PIECES, 8½ in. × 5 in

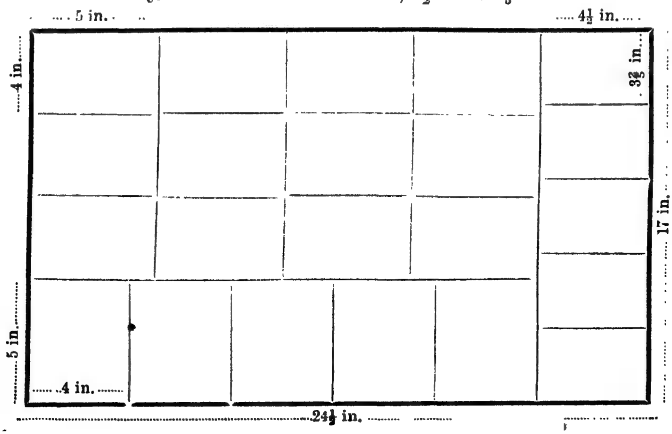




In addition, for C.D.V.'s the sheet is divided into seven each way, and the result is 49 pieces of ample size for trimming. As for the larger sizes, we get four pieces 10 × 8 and three pieces 5 × 4, whilst of 12 × 10 we get two pieces, and five pieces half-plate.

5 in. × 4 in.—12 PIECES.

QUARTER-PLATE—5 PIECES, $4\frac{1}{2}$ in. × $3\frac{3}{5}$ in.



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A

B.

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D.

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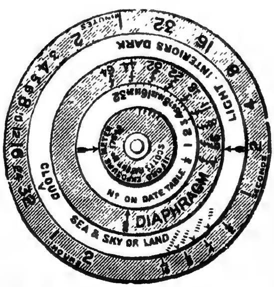

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